Marconi
Instruments

10 MHz-520 MHz AM/FM
SIGNAL GENERATOR
TF 2015

Instruction Manual

No. EB 2015

for

10 MHz - 520 MHz AM/FM Signal Generator TF 2015

MARCONI INSTRUMENTS LIMITED
ST. ALBANS HERTFORDSHIRE ENGLAND

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Contents

NOTES AND CAUTIONS

ELECTRICAL SAFETY PRECAUTIONS

This equipment is protected in accordance with IEC Safety Class 1. It has been designed and tested according to IEC Publication 348, 'Safety Requirements for Electronic Measuring Apparatus', and has been supplied in a safe condition. The following precautions must be observed by the user to ensure safe operation and to retain the equipment in a safe condition.

Defects and abnormal stresses

Whenever it is likely that protection has been impaired, for example as a result of damage caused by severe conditions of transport or storage, the equipment shall be made inoperative and be secured against any unintended operation.

Removal of covers

Removal of the covers is likely to expose live parts although reasonable precautions have been taken in the design of the equipment to shield such parts. The equipment shall be disconnected from the supply before carrying out any adjustment, replacement or maintenance and repair during which the equipment shall be opened. If any adjustment, maintenance or repair under voltage is inevitable it shall only be carried out by a skilled person who is aware of the hazard involved.

Note that capacitors inside the equipment may still be charged when the equipment has been disconnected from the supply. Before carrying out any work inside the equipment, capacitors connected to high voltage points should be discharged; to discharge mains filter capacitors, if fitted, short together the L (live) and N (neutral) pins of the mains plug.

Mains plug

The mains plug shall only be inserted in a socket outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension lead without protective conductor. Any interruption of the protective conductor inside or outside the equipment is likely to make the equipment dangerous. Before fitting a non-soldered plug to the mains lead, cut off the tinned ends of the mains lead. Otherwise cold flowing of the solder could cause intermittent connections.

Fuses

Note that there is a supply fuse in both the live and neutral wires of the supply lead. If only one of these fuses should rupture, certain parts of the equipment could remain at supply potential.

To provide protection against breakdown of the supply lead, its connectors, and filter where fitted, an external supply fuse (e.g. fitted in the connecting plug) should be used in the live lead. The fuse should have a continuous rating not exceeding 6 A.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

RADIO FREQUENCY INTERFERENCE

This equipment conforms with the requirements of IEC Directive 76/889 as to limits of r.f. interference.

CAUTION : STATIC SENSITIVE COMPONENTS

Components identified with the symbol ⚠ on the circuit diagrams and/or parts lists are static sensitive devices. The presence of such devices is also indicated in the equipment by orange discs, flags or labels bearing the same symbol. Certain handling precautions must be observed to prevent these components being permanently damaged by static charges or fast surges.

(1) If a printed board containing static sensitive components (as indicated by a warning disc or flag) is removed, it must be temporarily stored in a conductive plastic bag.

(2) If a static sensitive component is to be removed or replaced the following anti-static equipment must be used.

A work bench with an earthed conductive surface.

Metallic tools earthed either permanently or by repeated discharges.

A low-voltage earthed soldering iron.

An earthed wrist strap and a conductive earthed seat cover for the operator, whose outer clothing must not be of man-made fibre.

(3) As a general precaution, avoid touching the leads of a static sensitive component. When handling a new one, leave it in its conducting mount until it is required for use.

WARNING : HANDLING HAZARDS

This equipment is formed from metal pressings and although every endeavour has been made to remove sharp points and edges care should be taken, particularly when servicing the equipment, to avoid minor cuts.

WARNING : TOXIC HAZARD

Many of the electronic components used in this equipment employ resins and other chemicals which give off toxic fumes on incineration. Appropriate precautions should therefore be taken in the disposal of these items.

Beryllia (beryllium oxide) is used in the construction of the following components in this equipment :

Chapter 4 MAINTENANCE

Chapter 5 REPAIR

Chapter 6 REPLACEABLE PARTS

Chapter 7 CIRCUIT DIAGRAMS

Chapter 1

General information

1.1 INTRODUCTION

TF 2015 is a general purpose a.m./f.m. signal generator covering the frequency range 10 MHz to 520 MHz in eleven switched bands. Fundamental frequency generation is by voltage tuned oscillators which, in conjunction with the panel mounted controls, enable easy tuning to narrow band communication receivers up to the highest carrier frequencies.

Outputs up to 200 mV e.m.f. can be obtained with up to 80% a.m. or up to 400 mV e.m.f. for c.w. or f.m. Output is maintained constant over the whole frequency range by an automatic level control loop and is adjustable by coarse and fine attenuators calibrated in dBm in 50 Ω. An auxiliary output is available for driving a counter or digital synchronizer.

Amplitude modulation and frequency modulation are both derived from an internal 1 kHz oscillator. AM depth is variable up to 80% by a directly calibrated control. FM is directly calibrated in two full-scale ranges of 10 kHz and 100 kHz peak deviation. External modulation may also be applied and a mixed a.m. and f.m. facility is available.

The instrument, which is compact and portable, can be operated from a.c. supplies or from an external battery.

Fig. 1.1 10 MHz 520 MHz AM FM Signal Generator TF 2015

1.2 DATA SUMMARY

FREQUENCY

Range :	10 MHz to 520 MHz in 11 ranges : 10.0 MHz to 14.3 MHz 14.3 MHz to 20.5 MHz 20.5 MHz to 29.4 MHz 29.4 MHz to 42.0 MHz 42.0 MHz to 60.0 MHz 60.0 MHz to 86.0 MHz 86 MHz to 124 MHz 124 MHz to 177 MHz 177 MHz to 254 MHz 254 MHz to 363 MHz 363 MHz to 520 MHz
Discrimination :	Suitable for tuning into a receiver with a 6 kHz bandwidth (±3 kHz at -3 dB points).
Calibration accuracy :	±1.5% with extra fine tune control centred.
Stability :	At a constant ambient temperature in the range +10 °C to +35°C and after 2 hours from switch on the drift does not exceed 2 parts in 10^5 in 5 minutes.

RF OUTPUT

Level :	-127 dBm to -7 dBm (0.2 μV to 200 mV e.m.f.) with up to 80% a.m.; up to -1 dBm (400 mV e.m.f.) with no a.m.
Attenuators :	Coarse : 11 steps of 10 dB. Fine : 0 to 10 dB continuously variable, directly calibrated in dBm.
ALC :	With a terminated output, automatic level control maintains the level meter indication substantially constant.
Total level accuracy : (above 2 μV e.m.f.)	With carrier switch in the on position : ±1 dB up to 100 MHz ±2 dB above 100 MHz
Source impedance :	50 Ω. VSWR better than 1.3:1 with 10 dB or more in the coarse attenuator.
Counter output :	Greater than 80 mV into 50 Ω
Leakage radiation :	Up to 520 MHz with a receiver sensitivity set at 1.0 μV, a 1 inch 2-turn loop feeding the receiver cannot detect a signal of this level at a distance greater than 1 inch from generator. Allows measurements to be made on receivers with sensitivities down to 0.1 μV.

AMPLITUDE MODULATION

Depth :	Continuously variable up to an indicated 80% by directly calibrated control.
Monitor :	Reference level indicator.
Calibration accuracy :	±5% modulation depth at an indicated 30% rising to ±10% modulation depth at an indicated 80%.
Envelope distortion :	Less than 5% at modulation depths up to 30%.
Internal frequency :	1 kHz ±10%.
AF output :	Fixed level greater than 1.5 V r.m.s. into 10 kΩ.
External frequency range :	50 Hz to 20 kHz.
External input requirement :	Less than 1.5 V r.m.s. into 1 kΩ to set reference level.

FREQUENCY MODULATION

Deviation :	Continuously variable in two ranges with full-scale settings of 10 kHz and 100 kHz.
Frequency modulation performance :	Accuracy within ±15% of range full-scale at 1 kHz modulating frequency. Distortion less than 3% using internal modulating oscillator. However, between 11 MHz and 60 MHz the maximum deviation is 15 kHz for 3% distortion and ±15% accuracy. Within this frequency range deviation above 15 kHz may be subject to an additional 2% distortion and an additional -5% deviation error.
Monitor :	Reference level indicator.
Internal frequency :	1 kHz ±10%.
External frequency response characteristics :	50 Hz to 20 kHz within ±1 dB of the response at 1 kHz. Usable over modulation frequency range 30 Hz to 100 kHz.
External input requirement :	Less than 1.5 V r.m.s. into 1 kΩ to set reference level.

SPURIOUS SIGNALS

Carrier harmonics :	At least 26 dB below the carrier at output levels up to -7 dBm.
Non-harmonic components : (coherent)	None.
FM on c.w. :	With telephone psophometric weighting, equivalent deviation is less than 60 Hz up to 254 MHz and less than 100 Hz up to 520 MHz.

AM on c.w.:	With telephone psophometric weighting, less than 0.2% modulation depth.
FM on a.m.:	With telephone psophometric weighting, less than 500 Hz deviation at 30% modulation depth with 1 kHz modulation frequency.
AM on f.m.:	With telephone psophometric weighting, at 30 kHz deviation, less than 3% a.m. above 21 MHz and 5% a.m. below.

POWER REQUIREMENTS

AC mains :	Any voltage within the extreme limits 190 to 264 V or 95 to 132 V, at any frequency between 45 Hz and 500 Hz. Consumption: approx. 10 VA.
External d.c. :	24 V to 32 V (negative earth).

SAFETY	Complies with IEC and BS 4743 safety requirements.
RADIO FREQUENCY INTERFERENCE	Conforms to the requirements of EEC directive 76/889 as to limits of r.f. interference.

LIMIT RANGE OF OPERATION

Temperature :	0 to 55°C

CONDITIONS OF STORAGE AND TRANSPORT

Temperature :	-40°C to +70°C.
Humidity :	Up to 90% relative humidity.
Altitude :	Up to 2500 m (pressurized freight at 25 kN/m^2 differential, i.e. 3.7 lbf/m^2).

DIMENSIONS & WEIGHT

Height	*Width*	*Depth*	*Weight*
140 mm $5\frac{1}{2}$ in	286 mm $11\frac{1}{4}$ in	311 mm $12\frac{1}{4}$ in	5.4 kg 12 lb

1.3 VERSIONS AND ACCESSORIES

Code No	Versions
52015-015	Standard version.
52015-301	(Joint Services designation : Generator Signal CT584/2). Alternative version with BNC counter output connector and additional accessories.

Accessories supplied

43129-071	Mains cable.
23443-814	Adapter BNC to TNC.
43126-012	RF cable TM 4969/3, BNC plug to BNC plug.
41690-102	Protective front panel cover.
46883-209	(Supplied with 52015-301 only) Spare fuses kit comprising :- 2 off 23411-054, 160 mA time lag, 2 off 23411-055, 250 mA time lag, 2 off 23411-056, 0.5A time lag.

Accessories available

41690-044	Carrying case.
44411-001	Matching unit TM 5569; a series 25 Ω resistor that converts the effective source impedance of the generator from 50 Ω to 75 Ω. BNC socket to Belling-Lee type L734/P plug.
44411-019	Matching T pad TM 5573/3, for matching to 75 Ω loads. Input/output voltage ratio 2:1. BNC plug to BNC socket.
44425-501	20 dB attenuator pad TM 5573; BNC plug to BNC socket.
43281-007	RF fuse unit TM 9884; for protecting attenuator resistors when connecting to active loads. BNC plug to BNC socket.
54451-121	455 kHz i.f. probe
54451-061	470 kHz i.f. probe
54451-071	10.7 MHz i.f. probe

each provides a crystal controlled signal at a standard i.f. for use in receiver alignment.

54127-231	Shelf rack mounting kit (single)
54127-241	Shelf rack mounting kit (double)

Fitting instructions are included in the kit.

Chapter 2

Operation

2.1 PRELIMINARY REQUIREMENTS

Prior to connecting the instrument to the a.c. supply check that :

(1) The voltage selector switch is set to accept the local supply (voltage regulation eliminates transformer tap changing except between 95/132 V and 190/264 V ranges).

To change the range, remove the locking plate, set the switch correctly, reverse the plate and refit.

(2) Fuses are of the required rating - see Sect. 2.4 - and secure in the holders.

2.2 AC SUPPLY CABLE

The a.c. supply cable is fitted at one end with a female plug which connects with the instrument. When fitting the supply plug ensure that the conductors are connected as follows :

Earth	-	Green/yellow
Neutral	-	Blue
Live	-	Brown

2.3 BATTERY OPERATION

For battery operation it is only required to connect a 24 V battery to the appropriate terminals located at the rear of the instrument.

A mains/battery switch is not provided since this input functions automatically and the circuits are protected against reverse polarity. This feature could be used for emergency standby battery operation which would cut in automatically in the event of a mains supply failure.

2.4 FUSES

For a.c. operation the instrument is normally supplied with 2 fuses (FS1 & FS3) rated at 160 mA and with the mains selector switch set for supply voltages of 190 to 264 V. For mains voltages of 95 to 132 V change the fuses for those rated at 250 mA.

For battery operation, the input circuit incorporates a fuse (FS2) rated at 500 mA.

All fuses are slow blow (time lag) types.

Note. To avoid damage to the resistors in the coarse RF OUTPUT attenuator RF Fuse Unit TM 9884 (43281-007) should be used when TF 2015 is applied to the testing of transceivers.

2.5 CONTROLS AND CONNECTORS

Front panel Fig. 2.1

(1) AC SUPPLY switch. Positioned up to switch ON.

(2) PILOT LAMP. Lit when a.c. supply is switched on or when external battery is connected.

(3) CARRIER switch. Set at ON for normal c.w., f.m., or a.m. operation. The +6 dB position provides a high output for c.w. or f.m. only. The OFF position allows the carrier to be switched off without switching the instrument off. (See Sect. 2.20)

(4) CARRIER RANGE switch. Selects the required frequency range and exposes the appropriate tuning scale.

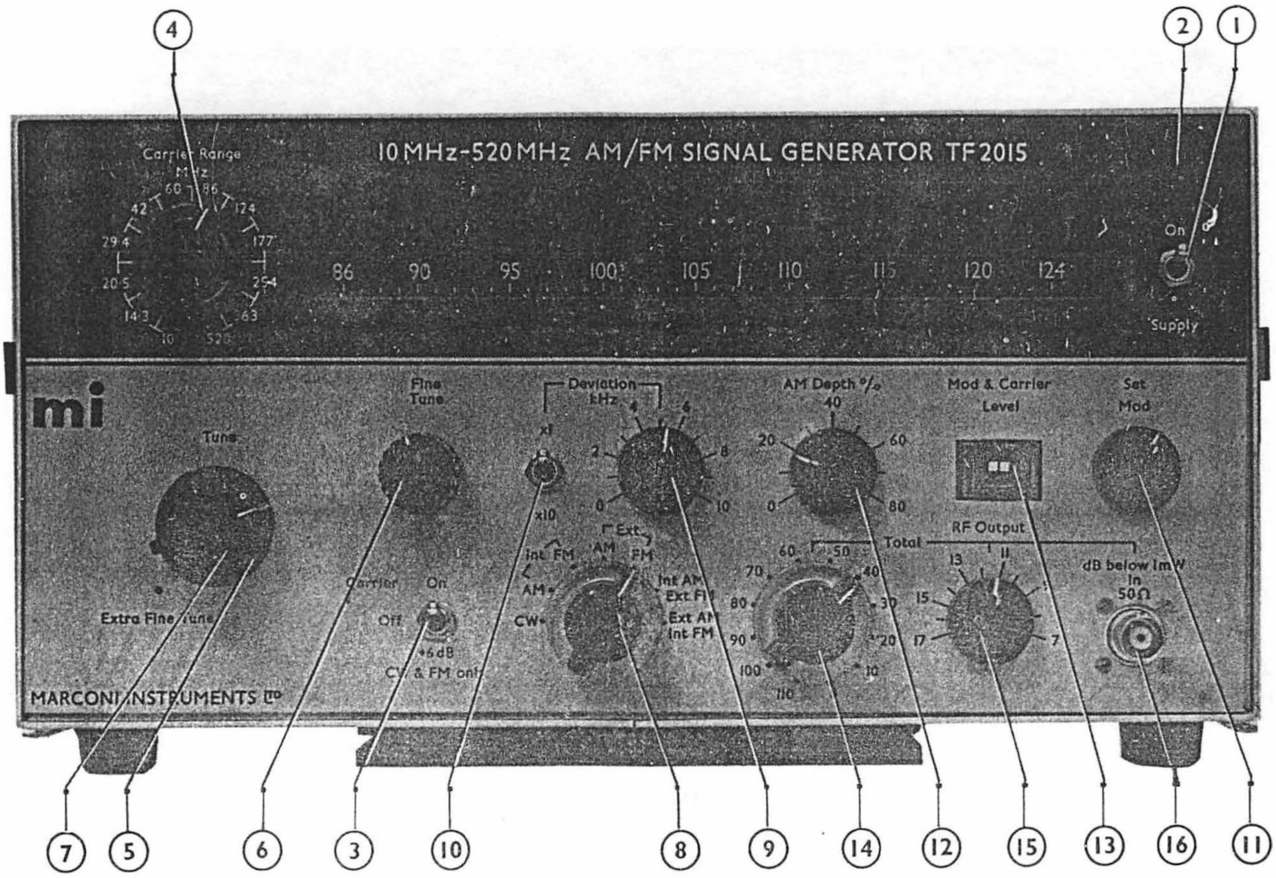


Fig. 2.1 Front panel controls

(5) TUNE control. This is a nineteen position switch to set the generator approximately to the required frequency.

(6) FINE TUNE control. Provides continuous tuning between each of the nineteen positions of (5) above.

(7) EXTRA FINE TUNE control. An uncalibrated fine tuning control which allows very precise setting of the carrier frequency.

(8) FUNCTION switch. Selects c. w., internal or external a. m. or f. m. or simultaneous f. m. and a. m.

(9) DEVIATION control. Full-scale value is 10 or 100 kHz depending on setting of x1, x10 multiplier.

(10) DEVIATION x1, x10. Multiplier for use with DEVIATION control.

(11) SET MOD control. Adjusted to set the pointer of the MOD & CARRIER LEVEL meter to the reference mark for f. m. or a. m.

(12) AM DEPTH. Adjusted to provide the desired a.m. depth from 0 to 80%.

(13) MOD & CARRIER LEVEL meter. Indicates correct reference level for a.m. and f. m. and also correct a. l. c. operation in the c. w. mode.

(14) RF OUTPUT (coarse). Stepped attenuator providing increments of 10 dB from 0 to 110 dB.

(15) RF OUTPUT (fine). Continuously variable to interpolate between 10 dB steps.

(16) RF OUTPUT connector. BNC 50 Ω. Output in - dBm given by sum of coarse and fine RF OUTPUT control settings. Add +6 dB when CARRIER switch is in +6 dB position. (See Sect. 2.20)

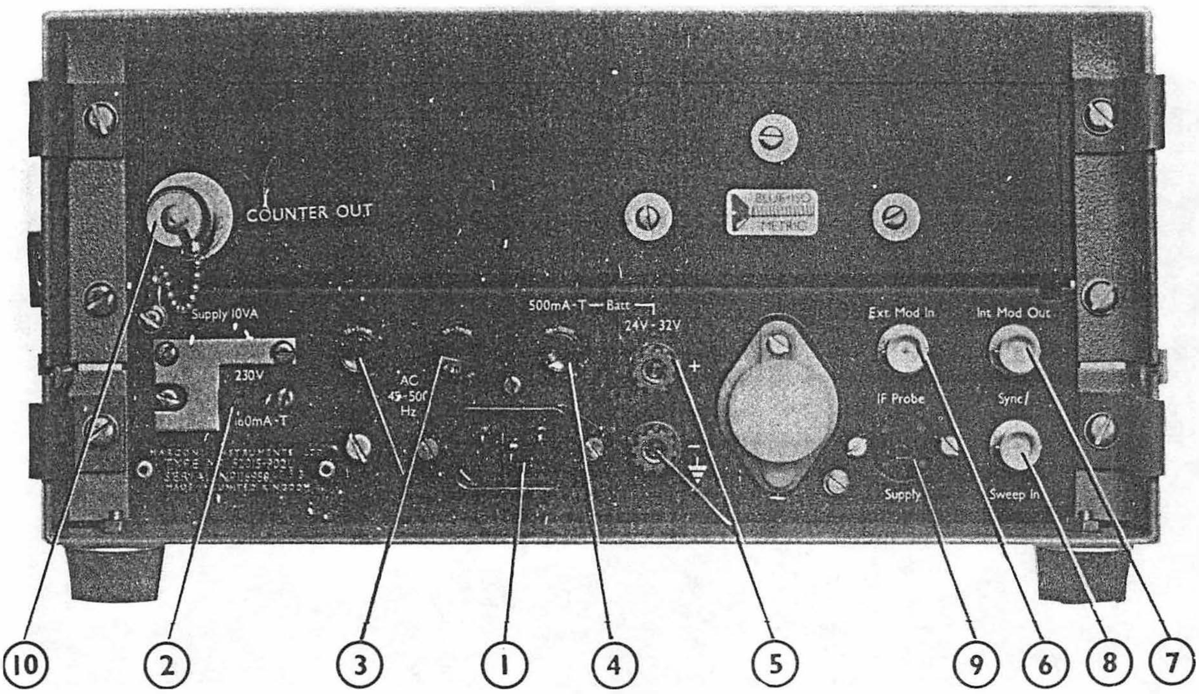


Fig. 2.2 Rear panel connectors

Rear panel Fig. 2.2

(1) MAINS INPUT connector. Bulgin P580. The a.c. supply is connected through this plug which mates with the connector fitted to the supplied mains cable.

(2) VOLTAGE SELECTOR switch. Selects either 95 to 132 V or 190 to 264 V to suit local a.c. supply.

(3) AC FUSES (FS1 & FS3). Mains input fuses rated at 160 mA (time lag) for 190 to 264 V or 250 mA (time lag) for 90 to 132 V.

(4) BATTERY FUSE (FS2). Battery input fuse rated at 500 mA (time lag).

(5) BATTERY TERMINALS. Battery input terminals (negative is connected to chassis).

(6) EXT MOD IN connector. BNC input for external modulation.

(7) INT MOD OUT connector. BNC. 1 kHz internal modulation oscillator output when FUNCTION switch is set at INT AM or FM.

(8) SYNC/SWEEP IN connector. BNC, accepts a frequency sweep voltage or the control voltage from a digital synchronizer.

(9) IF PROBE SUPPLY connector. DIN loud-speaker socket provides + 22 V for external i.f. probe.

(10) COUNTER OUT. BNC (or TNC) 50 Ω. For connection to an external counter or digital synchronizer.

2.6 SETTING FREQUENCY

(1) Set SUPPLY switch at ON and check that the pilot lamp is lit.

(2) Using the output cable supplied connect TF 2015 to the equipment under test.

(3) Set FUNCTION switch at CW and the CARRIER RANGE switch to select the desired frequency range.

(4) Set CARRIER switch at ON and check that the meter pointer is within the white box.

(5) Rotate the stepped TUNE control to position the pointer of the tuning scale as close as possible to the desired frequency. Then adjust the FINE TUNE control to position the pointer correctly. For final precise adjustment use the EXTRA FINE TUNE control.

Note : After thermal equilibrium has been reached the typical band switching restabilization time is 10 minutes.

2.7 CW OUTPUT

For an unmodulated c. w. output.

(1) Set FUNCTION switch at CW.

(2) For normal operation set CARRIER switch at ON and check that the meter pointer is within the white box. For extra output set CARRIER switch at +6 dB. (See Sect. 2.20)

(3) Set RF OUTPUT controls as required.

2.8 INTERNAL AMPLITUDE MODULATION

(1) Set FUNCTION switch at INT AM and CARRIER switch at ON. Note: amplitude modulation is not possible when CARRIER switch is at +6 dB.

(2) Adjust SET MOD control to position the meter pointer at the centre of the white box.

(3) Adjust AM DEPTH control to provide desired modulation. This control is direct reading with an accuracy which varies such that the true modulation depth may lie between 25% and 35% when 30% is indicated or between 70% and 90% when 80% is indicated.

2.9 INTERNAL FREQUENCY MODULATION

(1) Set FUNCTION switch at INT FM and CARRIER switch at ON. For extra output set CARRIER switch at +6 dB.

(2) Adjust SET MOD control to position the meter pointer at the centre of the white box.

(3) Adjust DEVIATION control to provide a deviation from 0 to 10 kHz (with multiplier at x1) or 0 to 100 kHz (with multiplier at x10).

2.10 EXTERNAL AM OR FM

(1) Set FUNCTION switch to appropriate position i.e. : EXT AM or EXT FM and CARRIER switch at ON.

Note: external a. m. is not possible when CARRIER switch is at +6 dB.

(2) Connect the external modulation source to EXT MOD IN (on rear panel); then adjust its level to position the meter pointer at the centre of the white box.

(3) The desired modulation depth or deviation is then obtained by adjusting the relevant controls i.e. : AM DEPTH or DEVIATION.

2.11 INTERNAL AM WITH EXTERNAL FM

(1) Set FUNCTION switch at INT AM and CARRIER switch at ON.

Note: amplitude modulation is not possible when CARRIER switch is at +6 dB.

(2) Adjust the SET MOD control to position the meter pointer at the centre of the white box.

(3) Connect the external modulation source to EXT MOD IN (on rear panel).

(4) Set FUNCTION switch at EXT FM. Then adjust the level of the external modulation to position the meter pointer at the centre of the white box.

(5) Set FUNCTION switch at INT AM/EXT FM. Then adjust AM DEPTH and DEVIATION controls to provide the required levels of modulation.

2.12 INTERNAL FM WITH EXTERNAL AM

(1) Set FUNCTION switch at INT FM and CARRIER switch at ON.

Note: amplitude modulation is not possible when CARRIER switch is at +6 dB.

(2) Adjust the SET MOD control to position the meter pointer at the centre of the white box.

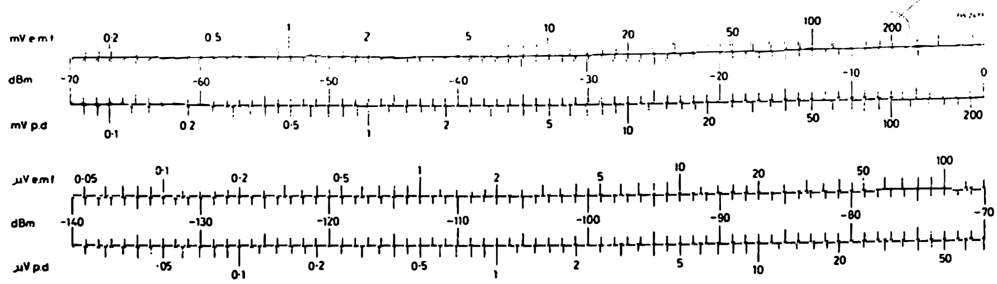


Fig. 2.3 Conversion scale: dBm to e.m.f. and p.d.

(3) Connect the external modulation source to EXT MOD IN (rear panel).

(4) Set FUNCTION switch at EXT AM. Then adjust the level of the external modulation to position the meter pointer at the centre of the white box.

(5) Set FUNCTION switch at EXT AM/INT FM. Then adjust AM DEPTH and DEVIATION controls to provide the required levels of modulation.

2.13 INTERNAL MODULATION OUTPUT

When FUNCTION switch is at INT AM, INT FM, INT AM/EXT FM, or EXT AM/INT FM, the 1 kHz modulating signal at a nominal 1 V (into a high impedance load), is available at the INT MOD OUT connector on rear panel. This signal may be used, for example, to trigger an oscilloscope at the modulating frequency or for a. f. tests.

2.14 OPERATION WITH DIGITAL SYNCHRONIZER

TF 2015 can be used with a digital synchronizer for a high degree of frequency stability. The synchronizer is driven from the COUNTER OUTPUT socket (rear of instrument) and its control voltage is applied to the SYNC/SWEEP connector.

2.15 SWEEP FACILITY

A voltage swing of 0 to +18 V applied to the SYNC/SWEEP IN connector will vary the carrier frequency over the frequency coverage of any one range. If a linear sweep is required, a suitable non-linear waveform must be used and to maintain the r. f. levelling accuracy, slow sweep speeds are necessary.

2.16 ATTENUATOR CALIBRATION

The RF OUTPUT controls (coarse and fine attenuators) are calibrated in dBm. Where e. m. f. or p. d. levels are to be used reference should be made to the conversion scale on the top of the instrument. The scale is as shown in Fig. 2. 3.

2.17 MATCHING TO HIGH IMPEDANCE LOADS

To match a load that is greater than 50 Ω to the output of TF 2015 a resistor R_S is required to be added in series with the generator output as in Fig. 2. 4. The value of R_S is given by the difference between the load and the generator impedances, i. e.

$$R_S = R_L - R_o$$

in which case the voltage across the load, V_L, is given by

$$V_L = \frac{E}{2}$$

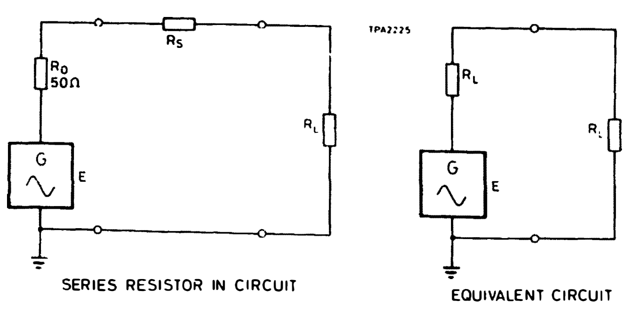


Fig. 2.4 High impedance matching

When a series resistor is employed to match a receiver input impedance of 75 Ω the output impedance of the signal generator will be mismatched. Therefore it is preferable to use Matching Pad type TM 5573/3 giving a convenient 2:1 attenuation. Using this pad both the output impedance of the generator and the input impedance of the receiver are correctly matched.

2.18 USE OF IF PROBES

The i.f. probes generate crystal controlled signals at customary receiver i.f's of 470 kHz and 10.7 MHz. They are powered from the 22 V IF PROBE plug on the generator. IF probes with other crystal frequencies can be supplied to special order.

The probes provide an auxiliary test signal for use in conjunction with the normal r.f. signal from the generator in receiver testing. In operation, the probe is positioned close to the receiver so that its signal is inductively coupled into the receiver i.f. circuit while the r.f. output from the generator is connected in the normal way to the receiver input.

This facilitates a number of receiver tests such as the following :

(1) Checking receiver i.f. When the signal generator is tuned to the nominal frequency of a receiver channel, any difference between the receiver i.f. and the probe frequency will produce a beat note in the receiver output. Readjusting the signal generator for zero beat, using the EXTRA FINE TUNE control, ensures that the generator is correctly tuned to the r.f. circuits in the receiver.

(2) Overriding receiver de-sensitization. It is often difficult to tune a signal generator to a receiver incorporating some forms of desensitization, such as squelch or a battery economizer, which respond to the presence of an i.f. signal. This is because the varying r.f. signal may traverse the receiver pass band too quickly, so that an i.f. signal is not present for long enough to sensitize the squelch or economizer circuit. By using the i.f. probe to inject an i.f. signal the receiver can be held in the sensitive condition while the r.f. generator is tuned into the pass band.

2.19 QUIETING SENSITIVITY MEASUREMENTS

(1) When making quieting sensitivity measurements on broadband equipments the carrier signal into the equipment under test can be removed by setting the CARRIER switch at OFF.

(2) For narrowband equipments e.g. mobile transceivers, the following procedure is preferable :

(a) Tune TF 2015 to the centre of the receiver pass band.

(b) Using the TUNE switch detune TF 2015 and note the noise output level of the receiver.

(c) Return the TUNE switch to its original position and then adjust the attenuator controls for the required quieting ratio - note the quieting sensitivity.

2.20 CORRECT USE OF THE +6 dB OUTPUT FACILITY

It should be noted that use of the +6 dB output facility is necessary only when c.w. outputs greater than 100 mV into 50 Ω are required e.g. :

With the CARRIER switch at ON and the coarse and fine RF OUTPUT controls at 0 and 7 dB respectively the output developed across a 50 Ω load will be 100 mV or 50 mV with the fine control at 13 dB (-6 dB). With the CARRIER switch at +6 dB and with the fine control at 13 dB the signal output level across 50 Ω then becomes 100 mV. Therefore, by adjusting the fine control from 13 dB to 7 dB the output level can be progressively increased from 100 mV to 200 mV.

Decibel conversion table

Ratio Down			*Ratio Up*	
VOLTAGE	*POWER*	*DECIBELS*	*VOLTAGE*	*POWER*
1·0	1·0	**0**	1·0	1·0
·9886	·9772	**·1**	1·012	1·023
·9772	·9550	**·2**	1·023	1·047
·9661	·9333	**·3**	1·035	1·072
·9550	·9120	**·4**	1·047	1·096
·9441	·8913	**·5**	1·059	1·122
·9333	·8710	**·6**	1·072	1·148
·9226	·8511	**·7**	1·084	1·175
·9120	·8318	**·8**	1·096	1·202
·9016	·8128	**·9**	1·109	1·230
·8913	·7943	**1·0**	1·122	1·259
·8710	·7586	**1·2**	1·148	1·318
·8511	·7244	**1·4**	1·175	1·380
·8318	·6918	**1·6**	1·202	1·445
·8128	·6607	**1·8**	1·230	1·514
·7943	·6310	**2·0**	1·259	1·585
·7762	·6026	**2·2**	1·288	1·660
·7586	·5754	**2·4**	1·318	1·738
·7413	·5495	**2·6**	1·349	1·820
·7244	·5248	**2·8**	1·380	1·905
·7079	·5012	**3·0**	1·413	1·995
·6683	·4467	**3·5**	1·496	2·239
·6310	·3981	**4·0**	1·585	2·512
·5957	·3548	**4·5**	1·679	2·818
·5623	·3162	**5·0**	1·778	3·162
·5309	·2818	**5·5**	1·884	3·548
·5012	·2512	**6**	1·995	3·981
·4467	·1995	**7**	2·239	5·012
·3981	·1585	**8**	2·512	6·310
·3548	·1259	**9**	2·818	7·943
·3162	·1000	**10**	3·162	10·000
·2818	·07943	**11**	3·548	12·59
·2512	·06310	**12**	3·981	15·85
·2239	·05012	**13**	4·467	19·95
·1995	·03981	**14**	5·012	25·12
·1778	·03162	**15**	5·623	31·62

Decibel conversion table (*continued*)

Ratio Down			*Ratio Up*	
VOLTAGE	POWER	DECIBELS	VOLTAGE	POWER
·1585	·02512	**16**	6·310	39·81
·1413	·01995	**17**	7·079	50·12
·1259	·01585	**18**	7·943	63·10
·1122	·01259	**19**	8·913	79·43
·1000	·01000	**20**	10·000	100·00
·07943	$6{\cdot}310 \times 10^{-3}$	**22**	12·59	158·5
·06310	$3{\cdot}981 \times 10^{-3}$	**24**	15·85	251·2
·05012	$2{\cdot}512 \times 10^{-3}$	**26**	19·95	398·1
·03981	$1{\cdot}585 \times 10^{-3}$	**28**	25·12	631·0
·03162	$1{\cdot}000 \times 10^{-3}$	**30**	31·62	1,000
·02512	$6{\cdot}310 \times 10^{-4}$	**32**	39·81	$1{\cdot}585 \times 10^{3}$
·01995	$3{\cdot}981 \times 10^{-4}$	**34**	50·12	$2{\cdot}512 \times 10^{3}$
·01585	$2{\cdot}512 \times 10^{-4}$	**36**	63·10	$3{\cdot}981 \times 10^{3}$
·01259	$1{\cdot}585 \times 10^{-4}$	**38**	79·43	$6{\cdot}310 \times 10^{3}$
·01000	$1{\cdot}000 \times 10^{-4}$	**40**	100·00	$1{\cdot}000 \times 10^{4}$
$7{\cdot}943 \times 10^{-3}$	$6{\cdot}310 \times 10^{-5}$	**42**	125·9	$1{\cdot}585 \times 10^{4}$
$6{\cdot}310 \times 10^{-3}$	$3{\cdot}981 \times 10^{-5}$	**44**	158·5	$2{\cdot}512 \times 10^{4}$
$5{\cdot}012 \times 10^{-3}$	$2{\cdot}512 \times 10^{-5}$	**46**	199·5	$3{\cdot}981 \times 10^{4}$
$3{\cdot}981 \times 10^{-3}$	$1{\cdot}585 \times 10^{-5}$	**48**	251·2	$6{\cdot}310 \times 10^{4}$
$3{\cdot}162 \times 10^{-3}$	$1{\cdot}000 \times 10^{-5}$	**50**	316·2	$1{\cdot}000 \times 10^{5}$
$2{\cdot}512 \times 10^{-3}$	$6{\cdot}310 \times 10^{-6}$	**52**	398·1	$1{\cdot}585 \times 10^{5}$
$1{\cdot}995 \times 10^{-3}$	$3{\cdot}981 \times 10^{-6}$	**54**	501·2	$2{\cdot}512 \times 10^{5}$
$1{\cdot}585 \times 10^{-3}$	$2{\cdot}512 \times 10^{-6}$	**56**	631·0	$3{\cdot}981 \times 10^{5}$
$1{\cdot}259 \times 10^{-3}$	$1{\cdot}585 \times 10^{-6}$	**58**	794·3	$6{\cdot}310 \times 10^{5}$
$1{\cdot}000 \times 10^{-3}$	$1{\cdot}000 \times 10^{-6}$	**60**	1,000	$1{\cdot}000 \times 10^{6}$
$5{\cdot}623 \times 10^{-4}$	$3{\cdot}162 \times 10^{-7}$	**65**	$1{\cdot}778 \times 10^{3}$	$3{\cdot}162 \times 10^{5}$
$3{\cdot}162 \times 10^{-4}$	$1{\cdot}000 \times 10^{-7}$	**70**	$3{\cdot}162 \times 10^{3}$	$1{\cdot}000 \times 10^{7}$
$1{\cdot}778 \times 10^{-4}$	$3{\cdot}162 \times 10^{-8}$	**75**	$5{\cdot}623 \times 10^{3}$	$3{\cdot}162 \times 10^{7}$
$1{\cdot}000 \times 10^{-4}$	$1{\cdot}000 \times 10^{-8}$	**80**	$1{\cdot}000 \times 10^{4}$	$1{\cdot}000 \times 10^{8}$
$5{\cdot}623 \times 10^{-5}$	$3{\cdot}162 \times 10^{-9}$	**85**	$1{\cdot}778 \times 10^{4}$	$3{\cdot}162 \times 10^{8}$
$3{\cdot}162 \times 10^{-5}$	$1{\cdot}000 \times 10^{-9}$	**90**	$3{\cdot}162 \times 10^{4}$	$1{\cdot}000 \times 10^{9}$
$1{\cdot}000 \times 10^{-5}$	$1{\cdot}000 \times 10^{-10}$	**100**	$1{\cdot}000 \times 10^{5}$	$1{\cdot}000 \times 10^{10}$
$3{\cdot}162 \times 10^{-6}$	$1{\cdot}000 \times 10^{-11}$	**110**	$3{\cdot}162 \times 10^{5}$	$1{\cdot}000 \times 10^{11}$
$1{\cdot}000 \times 10^{-6}$	$1{\cdot}000 \times 10^{-12}$	**120**	$1{\cdot}000 \times 10^{6}$	$1{\cdot}000 \times 10^{12}$
$3{\cdot}162 \times 10^{-7}$	$1{\cdot}000 \times 10^{-13}$	**130**	$3{\cdot}162 \times 10^{6}$	$1{\cdot}000 \times 10^{13}$
$1{\cdot}000 \times 10^{-7}$	$1{\cdot}000 \times 10^{-14}$	**140**	$1{\cdot}000 \times 10^{7}$	$1{\cdot}000 \times 10^{14}$

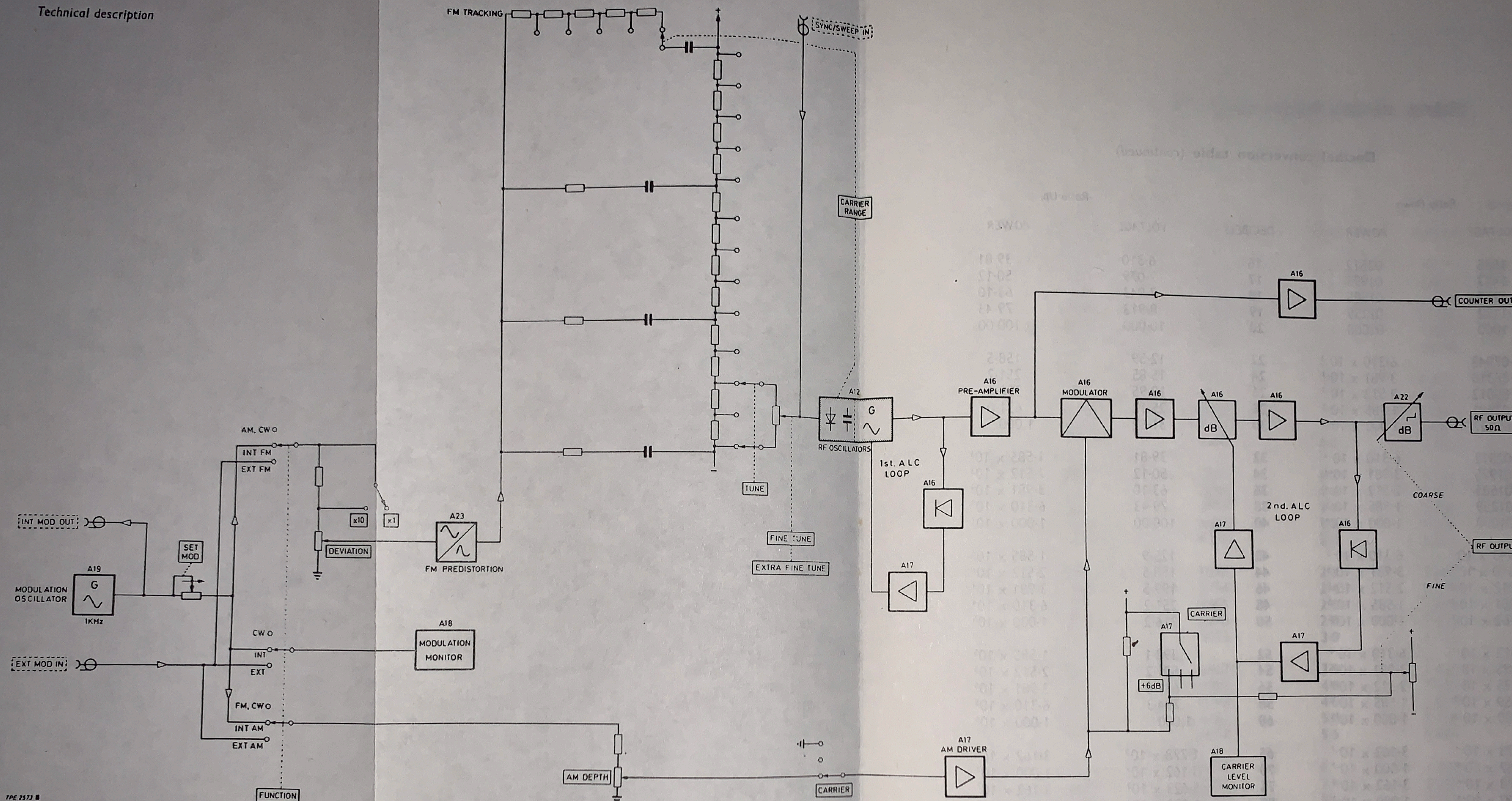


Fig. 3.1 Block diagram

Chapter 3 Technical description

This chapter, which outlines the overall and circuit functions of TF 2015, is intended to be read with reference to the circuit diagrams and illustrations contained within this manual.

3.1 MECHANICAL CHARACTERISTICS

All printed circuit boards and sub-assemblies in the instrument are allocated a unit identification number in the sequence A0 to A12 and A16 to A23 and where practical the assembly is marked with this number. The main sub-assembly layout is shown in Figs. 4.3 and 4.4.

Construction consists of front and rear panels supported by side frames which also carry an r. f. box. The r. f. box contains eleven separate oscillator circuits A1 to A11 mounted on a mother board A12 which is hinged to allow access to the associated components. The box also contains a screened compartment A16 containing the r. f. amplifier, modulator and counter amplifier circuits. The automatic level control (a. l. c.) circuits A17 are mounted on top of this compartment. The low r. f. leakage lid is retained by four fixing screws. The underside of the r. f. box carries the filter box and units A18, A19 and A20.

Units A21 and A23 are mounted on one of the side frames and the opposite frame carries the mains transformer. Inputs and outputs are conveyed through BNC connectors and terminals located on the front panel and at the rear of the instrument.

Since TF 2015 is a portable instrument, a removable cover is clasp fitted to the case to provide front panel protection and also stowage space for some accessories. A prop fixed to the lower section of the case enables the instrument to be tilted for easy operation of the controls.

3.2 OVERALL FUNCTION

A separate voltage tuned oscillator is used for each of the eleven ranges. Output from the selected oscillator, which is maintained at a constant level by the first automatic level control (a. l. c.) loop, is applied to a pre-amplifier.

The frequency of each oscillator is controlled by means of a pair of varactor diodes across the tuned circuit. The capacitance of the diodes, and hence the resonant frequency of the tuned circuit, is determined by the control voltage applied to the diodes. This arrangement provides for both tuning and frequency modulation, a variable d. c. control voltage being applied for tuning purposes and an a. f. modulating signal for f. m.

Output from the pre-amplifier is applied to a modulator and at a suitable level to a counter amplifier. The r. f. output from the modulator which is approximately 30 mV is passed to a wide band amplifier incorporating an interstage current controlled attenuator.

Output from the amplifier is applied to the input of the coarse attenuator (coarse r. f. output control) and through a detector circuit to a second a. l. c. loop which, operating in conjunction with the fine attenuator (fine r. f. output control) sets and then maintains the level of the r. f. input to the coarse attenuator.

The r. f. carrier can be amplitude or frequency modulated using either the internal modulation oscillator or an external signal. For a. m. the a. f. signal is applied to the modulator through a push-pull driver circuit and for f. m. to the tuning circuits. To ensure that deviation is maintained acceptably constant over each frequency range and to minimize distortion, tracking and pre-distortion circuits are employed.

A Wien bridge oscillator operating at a nominal frequency of 1 kHz is used for internal modulation and to provide an a. f. output. For both a. m. and f. m. the internal a. f. signal is routed through the SET MOD control which is adjusted to obtain a modulation reference level. The desired a. m. depth or f. m. deviation is then obtained by adjustment of the appropriately indicated controls.

Inputs are provided for connection of an external modulating signal and for application of a suitable sweep waveform. A 22 V d. c. output is available as a supply for certain associated equipments, e. g. i. f. probes, and an output is provided for connection to a frequency counter.

In c. w. operation the meter indicates correct operation of the a. l. c. In the modulated modes it monitors the a. f. reference level.

3.3 CIRCUIT FUNCTIONS

Block schematic diagram Fig. 3.1 inter-relates the various circuits employed in TF 2015 whilst the sections which follow explain the function of each.

3.4 RF OSCILLATORS

Circuit diagram Fig. 7.1 Unit A12 (sub-assemblies A1 to A11)

All the oscillators use a modified Hartley circuit and differ only in the value of components. Oscillators A1 to A9 employ a field effect transistor, A10 and A11 use bipolar transistors. Feedback is established by inductive coupling between the two sections of the primary winding of transformer T1.

Frequency is determined by varactor diodes D1 and D2 operating as variable capacitors to tune the primary winding of T1. The capacitance values of D1 and D2 are varied by application of d. c. voltage levels set by the tuning circuit A21.

For ranges 1 to 9, trimmer capacitor C4 is adjusted to correctly set the high frequency end of the range with the core of T1 adjusted at the low frequency end. On ranges 10 and 11 only C4 is adjustable.

The oscillators are individually activated by switched application of the d. c. supply whilst output from the selected oscillator is obtained from the secondary winding of T1 through the appropriate steering diode, D1 to D11. Diode D12 is incorporated to reduce the effective capacitance of D1 to D7 which could influence the frequency coverage of ranges 8 to 11.

3.5 TUNING AND FREQUENCY MODULATION

Circuit diagram Fig. 7.3 Units A19 and A21

Because the varactors used for tuning have a non-linear capacitance/voltage characteristic, a 19-position switch with a chain of selected resistors is used to provide a stepped linear change of frequency. Potentiometer A0R 38 interpolates between switch positions. The additional potentiometer A0R37 enables TF 2015 to be precisely tuned to a receiver under test.

For a frequency modulated output the a. f. signal is routed to the varactors through the f. m. controls, tracking resistors A0, R5 to R15, the pre-distortion circuit A23, amplifier TR3, TR4, TR5 and the tuning control circuits. The tracking resistors are automatically selected by the range selector switch to maintain equal deviation over each frequency range. A21 TR1 is used as a low impedance source for the f. m. drive.

3.6 FIRST ALC LOOP

Circuit diagram Fig. 7.2 Units A16 and A17

Output from the selected oscillator is maintained at a nominal level of 50 mV by the first automatic level control (a. l. c.) loop. The oscillator output is applied to a detector circuit, D1 and D2, which is referenced by the set voltage at the junction of R1 and R2 on A17.

Output from the detector is applied to one input of a differential pair, TR1 and TR2, where it is compared with a reference level preset by network R4, R5, R6 and R7. Any difference in the level of the signals either towards positive or negative appropriately varies the bias to TR3 which then varies the current in the f. e. t. in the selected oscillator to re-establish the required output level.

Diodes A17D1 and D2 compensate for the temperature changes of the detector diodes, A16D1 and D2. Capacitors A17, C2 and C11 are incorporated to minimize spurious f. m. which could be produced by a. l. c. circuit noise.

3.7 PRE-AMPLIFIER

Circuit diagram Fig. 7.2 Unit A16

The controlled output level from the selected oscillator is applied to a wide band pre-amplifier providing a gain of approximately 12 dB, i. e. a nominal output of 200 mV.

The circuit consists of four stages, TR1, TR2, TR3 and TR4, and employs both common base and common emitter configurations. The common base circuits and screens mounted on the printed circuit board are incorporated to provide the required inter-stage isolation.

3.8 MODULATOR AND AMPLITUDE MODULATION

Circuit diagram Fig. 7.2 Unit A16

The circuit configuration is basically that of a single balanced bridge modulator employing p-i-n diodes operating as variable (current controlled) r.f. resistors to achieve minimum r.f. carrier distortion.

Initially, with no d.c. or a.f. inputs, the two inputs from T1 are 180° out of phase and, since R17 and R18 are equal, the bias currents and consequently the resistance of the diodes are equal. With these conditions the bridge is balanced so no signal is present at T2.

To provide a constant r.f. output for c.w., d.c. offsets from circuits A17 TR7 and TR8 are applied to partially unbalance the bridge. For amplitude modulation the a.f. signal from the push-pull driver circuit A17 TR4, TR5 and TR6 is applied to the bridge modulator. The a.f. signal produces offset levels proportional to its amplitude so the bridge becomes progressively unbalanced to an extent which is greater or less during each positive and negative half cycle of the a.f. waveform.

3.9 COUNTER AMPLIFIER

Circuit diagram Fig. 7.2 Unit A16

Part of the r.f. signal voltage at the output of the pre-amplifier is applied to a common emitter amplifier, TR6, which serves to drive an external frequency counter. Output at the COUNTER OUT connector is nominally 100 mV into 50 Ω.

3.10 AM DRIVER AND DC OFFSET CIRCUITS

Circuit diagram Fig. 7.2 Unit A17

The two circuits TR7 and TR8 operate to set the level of the d.c. offsets applied to the modulator and consequently the r.f. level to A16 TR5.

With the CARRIER switch at ON (normal r.f. output) TR7 and TR8 are non-conducting so the d.c. offset levels to the modulator are determined by R23 and R24. When the CARRIER switch is at +6 dB TR7 and TR8 are switched on to connect R25 and R26 in parallel with R23 and R24 to further unbalance the modulator, reducing its insertion loss by approximately 8 dB. Diode D3 is incorporated to prevent current flowing in R26 when TR7 and TR8 are in the off condition.

The a.m. driver serving the modulator consists of a push-pull a.f. amplifier, TR4 and TR6, which applies offset levels proportional to the varying amplitude of the a.f. cycle to produce an amplitude modulated output as explained in Section 3.8. TR5 maintains the amplifier current constant during the a.f. cycle.

3.11 WIDE BAND AMPLIFIER

Circuit diagram Fig. 7.2 Unit A16

This consists of three common emitter stages TR5, TR7 and TR8 with an interstage current controlled variable attenuator. This operates in conjunction with the second a.l.c. loop and fine r.f. output control to set and maintain constant the signal level at the input to the coarse r.f. output attenuator unit A22.

The attenuator which controls the gain of the amplifier employs p-i-n diodes D7 and D8 as current controlled variable resistors, their resistance being determined by bias levels controlled by A17 TR9 and TR10 (see section 3.12).

3.12 SECOND ALC CIRCUIT

Circuit diagram Fig. 7.2 Unit A17

The signal level at the output of the wide band amplifier is detected by diodes D9 and D10 and and then passed to A17 IC1 where it is compared with a level dictated by the setting of the fine r.f. output control, A0R16. Any difference in level between the two applied signals causes the output of IC1 to change. This changes the currents through TR9 and TR10 which controls the resistance of the variable attenuator diodes, D7 and D8, and establishes the required input to the coarse r.f. output control (see Section 3.13).

3.13 FINE RF OUTPUT CONTROL

Circuit diagram Fig. 7.2 Units A16, A17, A18

The calibration accuracy of the fine r.f. output control is primarily dependent upon correct performance of the second a.l.c. loop incorporating circuits A18 TR2, the a.l.c. amplifier A17, the interstage attenuator circuit A16 D7 and D8 and the detector circuit A16 D9 and D10.

The circuit A18 TR2 provides a fixed reference voltage to the detector D9 and D10 to produce a voltage level at A17 IC1 pin 2 which is determined by the difference between the reference voltage and the detected r. f. voltage. It also provides a preset voltage to A17 IC1 pin 3 at a level which is dictated by the setting of the fine r. f. output control A0 R16. Output from IC1 pin 6, which depends on the voltage levels at pins 2 and 3, controls the current through the differential pair TR9 and TR10 such that the resistances of D7 and D8 in the interstage attenuator are set to establish the required amplifier gain and therefore the desired r. f. output level.

When the fine attenuator control A0 R16 is adjusted for a different r. f. output, the voltage levels at IC1 pins 2 and 3 will momentarily be unequal, which causes the output at IC1 pin 6 to change and consequently the current through TR9 and TR10. The increased or decreased current sets the attenuator D7 and D8 to appropriately vary the gain of the wide band amplifier to re-establish equal voltage levels at IC1 pins 2 and 3 and a higher or lower signal level to the input of A22.

3.14 MODULATION OSCILLATOR

Circuit diagram Fig. 7.3 Unit A19

A Wien bridge circuit operating at a nominal frequency of 1 kHz is employed for internal modulation of the r. f. signal and to provide an a. f. output at the INT MOD OUT connector.

The input of TR1 is connected across the shunt arm R2, C1 of the bridge and its output is passed to the amplifier circuit TR2. The oscillator output signal is across R8 and it is applied to the series arm of the bridge C2, R6 to obtain positive feedback. During the non-oscillating condition prior to 'switch on' the amplifier gain is high. At 'switch on' oscillation commences readily, causing the resistance of thermistor R7 to fall and the amplifier gain to stabilize at a value just sufficient to maintain oscillation.

For amplitude modulation the 1 kHz signal is routed through the SET MOD control and AM DEPTH control to the a. m. driver circuit A17.

For frequency modulation the 1 kHz signal is applied through the SET MOD control and DEVIATION controls to the switched f. m. tracking resistors A0 R5 to R15 (ganged to range selector switch) and then through the predistortion circuits A23 and f. m. driver TR3, TR4, TR5 to the tuning circuits A21.

3.15 PREDISTORTION CIRCUIT

Circuit diagram Fig. 7.3 Unit A23

This circuit, which is especially applicable to ranges 1 and 2, minimizes f. m. distortion by predistorting the a. f. waveform to compensate for the capacitance/voltage characteristic of the varactors. The circuit is designed to expand the positive half of the a. f. waveform and compress the negative half.

Circuit performance is largely dependent upon the attenuator R2 and R3 which is set by the shunt diodes D1 and D2.

During the positive half of the a. f. waveform D1 is caused to conduct by the positive signal level at A21 pin 13 and since D1 is effectively in parallel with R2 the insertion loss of the attenuator is reduced to increase the amplitude of the positive half of the waveform to the f. m. driver. During the negative half of the waveform D2 is caused to conduct, effectively reducing the value of R3 and limiting the waveform excursion.

The circuit consisting of R7 to R10 is designed to reduce frequency drift by appropriately varying the d. c. supply to the tuning network R17-R36 to compensate for temperature rise within the instrument.

3.16 6 dB OUTPUT

Circuit diagram Figs. 7.2 and 7.3 Units A16, A17, A18

When the CARRIER switch is at +6 dB the levels of the d. c. offsets to the modulator A16 are increased to reduce its insertion loss (see Section 3.10). Resistor R25 in the circuit A18 TR2 is connected (through D6) in parallel with R24 to increase the current through the network R22, R23 and A0 R16 and consequently the set voltage output from A0 R16 to IC1 pin 3. The a. l. c. loop then operates to increase the r. f. output by 6 dB.

With the CARRIER switch at +6 dB amplitude modulation is not possible and is prevented by connecting the a. m. drive line to earth.

3.17 MONITOR CIRCUITS

Circuit diagram Figs. 7.2 and 7.3 Unit A18

When the FUNCTION selector is set for a.m. or f.m. modulation the output from the internal or external modulation oscillator is routed to the monitor circuit A18 TR1.

The a.f. is rectified by the circuit D1 and D2 and the positive d.c. output is applied to the meter ME1 through the emitter follower TR1 and diode D3. To obtain the desired sensitivity the meter is backed off by a set d.c. level from the network R10, R11 and R12 and by preset adjustment of R5 which sets a reference level to the detector circuit D1 and D2. Thermistor R9 provides the necessary temperature compensation to the network R10, R11 and R12 while D3 prevents the application of reverse currents to TR1.

Since the calibration accuracy of the fine r.f. control is largely dependent upon the performance of the a.l.c. loop A17, the meter (when the FUNCTION selector is set at CW) serves only to indicate correct operation of the a.l.c. loop. The circuit R12 to R16 with R18 and R19 forms a limits bridge with R17 preset to position the pointer of the meter at the centre of the white box on the meter scale. Provided the output from A17 IC1 pin 6 remains within certain limits, diodes D4 and D5 are non-conducting.

Incorrect operation of the a.l.c., which could be caused by malfunction of the preceding r.f. circuits, produces an output from IC1 which will be above or below the expected limits. The appropriate diode then conducts causing the bridge condition to change such that the meter pointer will be positioned at zero or f.s.d.

3.18 COARSE RF OUTPUT CONTROL

Circuit diagram Fig. 7.4 Unit A22

This provides a loss of 110 dB in steps of 10 dB. The pad sections consist of resistive networks with a characteristic impedance of 50 Ω. The unit is divided into compartments to ensure maximum shielding between pads. Pads are connected into circuit by microswitches housed in screened compartments and operated in pairs by leaf springs actuated by cams on the control spindle.

3.19 POWER UNIT

Circuit diagram Fig. 7.4 Unit A20

The power unit, which operates by switch selection from a.c. supplies of 95 to 132 V or 190 to 264 V, 45 to 500 Hz, consists basically of mains transformer A0T1, a full wave rectifier circuit A20 D1, D2, D3 and D4 and a conventional voltage regulator circuit. The +22 V output from the regulator supplies all the circuits except the frequency control sections which are supplied from a second sub-stabilizer which provides +19 V. The 19 V regulator sampling lines maintain the voltage across the tuning network. TR6 and R9 provide a low noise voltage reference for the sub-stabilized supply.

3.20 SUPPLY FILTERS

Filters are incorporated in supply lines to various units to ensure that spurious r.f. signals are not introduced into the circuits.

All the filters are contained in a separately screened box which consists of two screen divided sections. Each filter employs two series connected chokes and lead-through type shunt capacitors.

Chapter 4

Maintenance

4.1 INTRODUCTION

This chapter contains information for keeping the equipment in good working order and for checking its overall performance. Before attempting any maintenance on the equipment you are advised to read the preceding Technical Description chapter.

4.2 SCREW FASTENERS

The majority of screw threads used in the instrument are metric of various sizes but in some positions BA threads are used. All chromium plated screws and all screws tinted blue are metric. Ensure that screws removed are refitted in original positions.

4.3 ACCESS TO SUB-ASSEMBLIES AND COMPONENTS

Removal of case

The case is in two sections. Remove the six screws at the rear of the instrument and then slide off top and bottom sections.

Sub-assemblies A1 to A12

A1 to A11 are r.f. oscillator assemblies mounted on a mother board. A12, which is contained within the r.f. box. To obtain access remove the cover of the r.f. box by removing the four fixing screws. Unit A12 is hinged to provide access to the oscillator assemblies as shown in Fig. 4.1. The component layout for each assembly is as shown in Fig. 4.2 and Fig. 4.4.

Units A16 and A17

The position of these units is shown in Figs. 4.1 and 4.4. Access to A16 is obtained by removing the four screws holding the screening plate and then by carefully folding this back with A17 attached. A17 is directly accessible - see Fig. 4.4.

Units A18, A19, A20, A21, A23

The position of these units is shown in Fig. 4.3 and all are directly accessible from the underside of the instrument.

Supply filters

These are contained in a separately screened compartment. Inputs and outputs can be accessed through the associated capacitors which are accessible by carefully lifting A18 upwards and folding A12 back as shown in Fig. 4.1.

Unit A22

To remove the attenuator, carefully disconnect the two semi-rigid coaxial cables, remove the control knob and nut holding the unit to the panel, remove the bracket screw then lift the unit from the chassis.

4.4 PRELIMINARY CHECKS

(1) Check to ensure that all switches are undamaged and operating correctly and verify that connectors are securely mated.

(2) Check that fuses are of the correct rating and type, and fit correctly in the holders.

4.5 TEST EQUIPMENT

The test equipment required for maintenance and repair of the instrument is listed in Table 4.1.

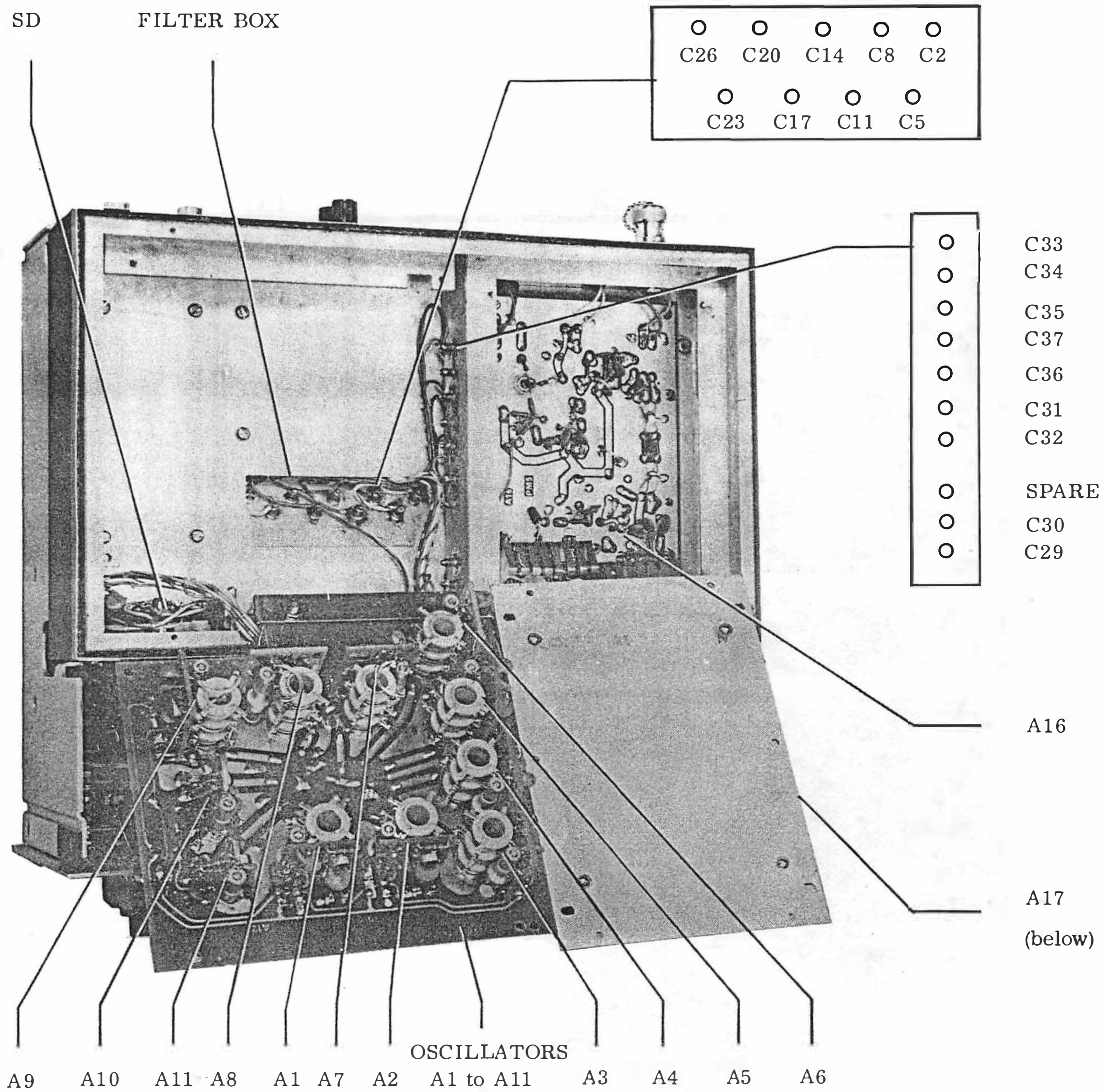


Fig. 4.1 Layout, top view with boards A12 and A17 hinged back

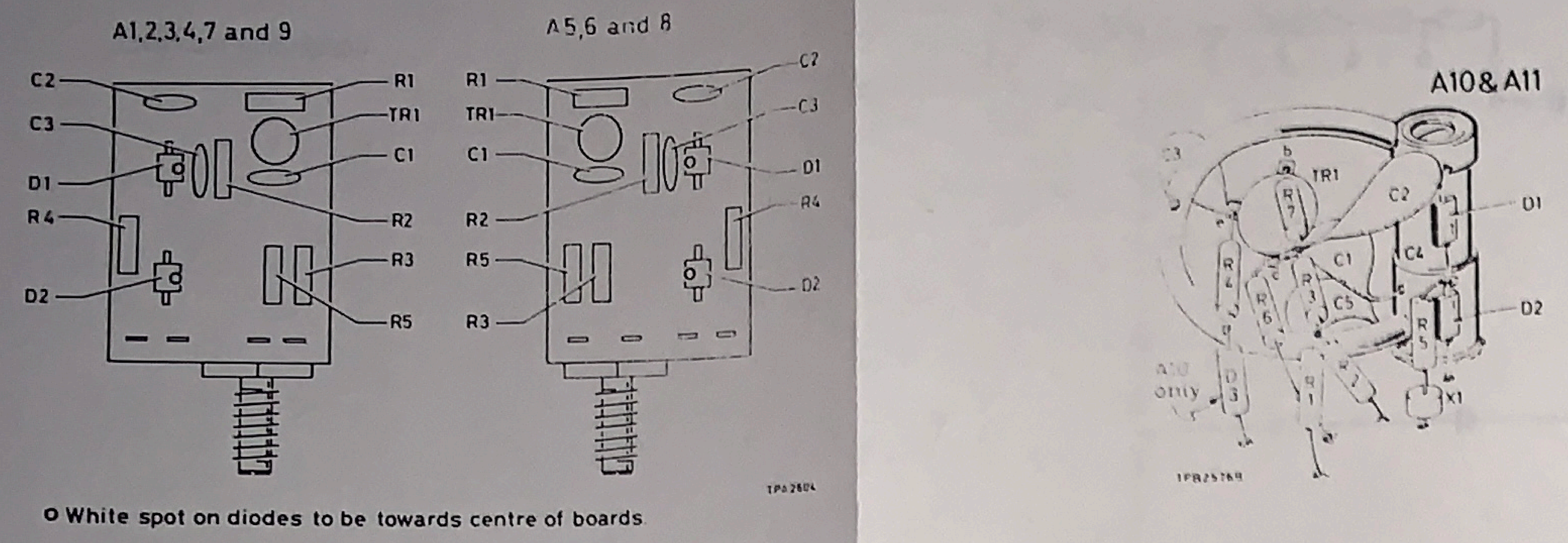


Fig. 4.2 Layout of oscillator assemblies

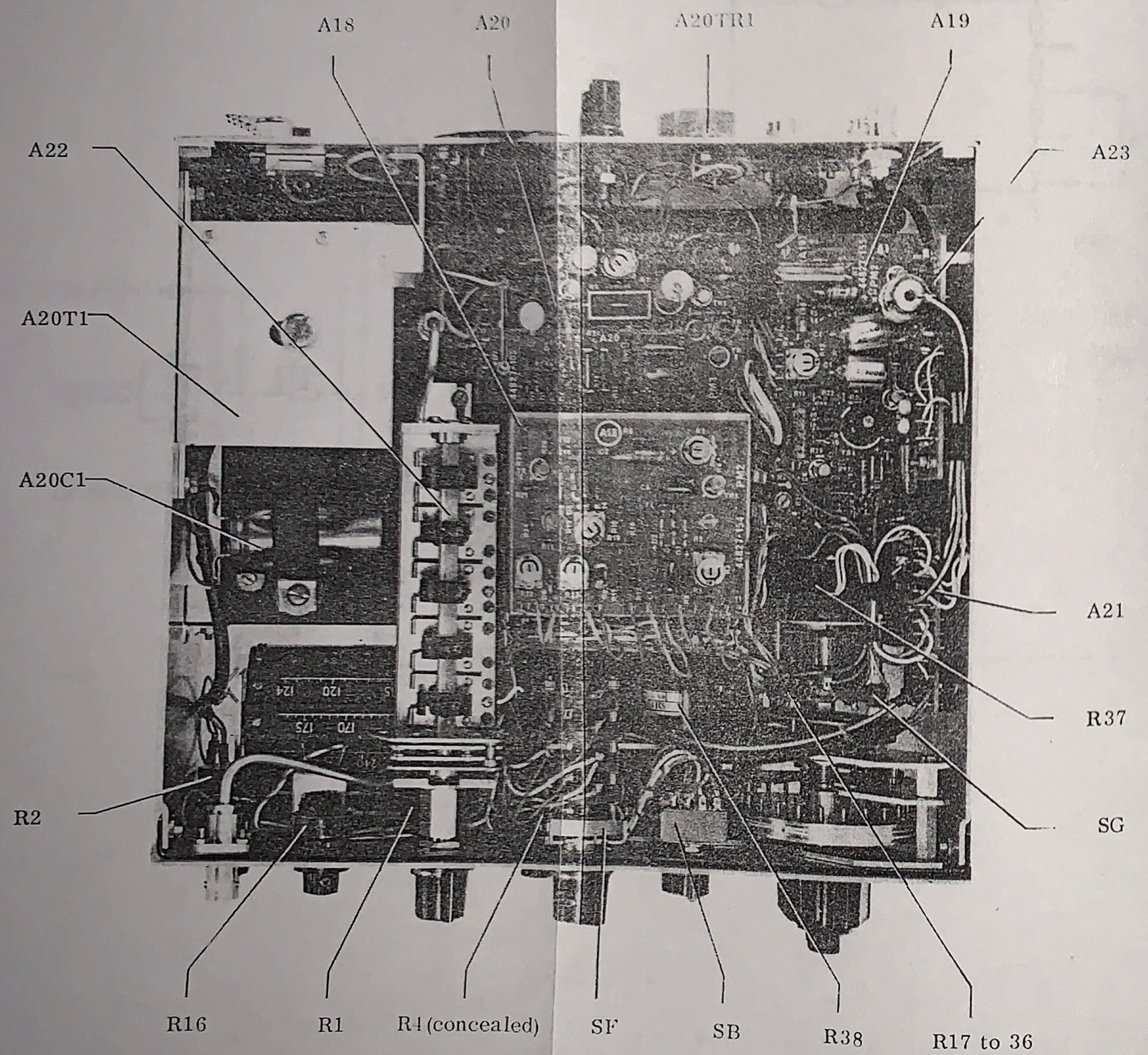


Fig. 4.3 Layout, bottom view

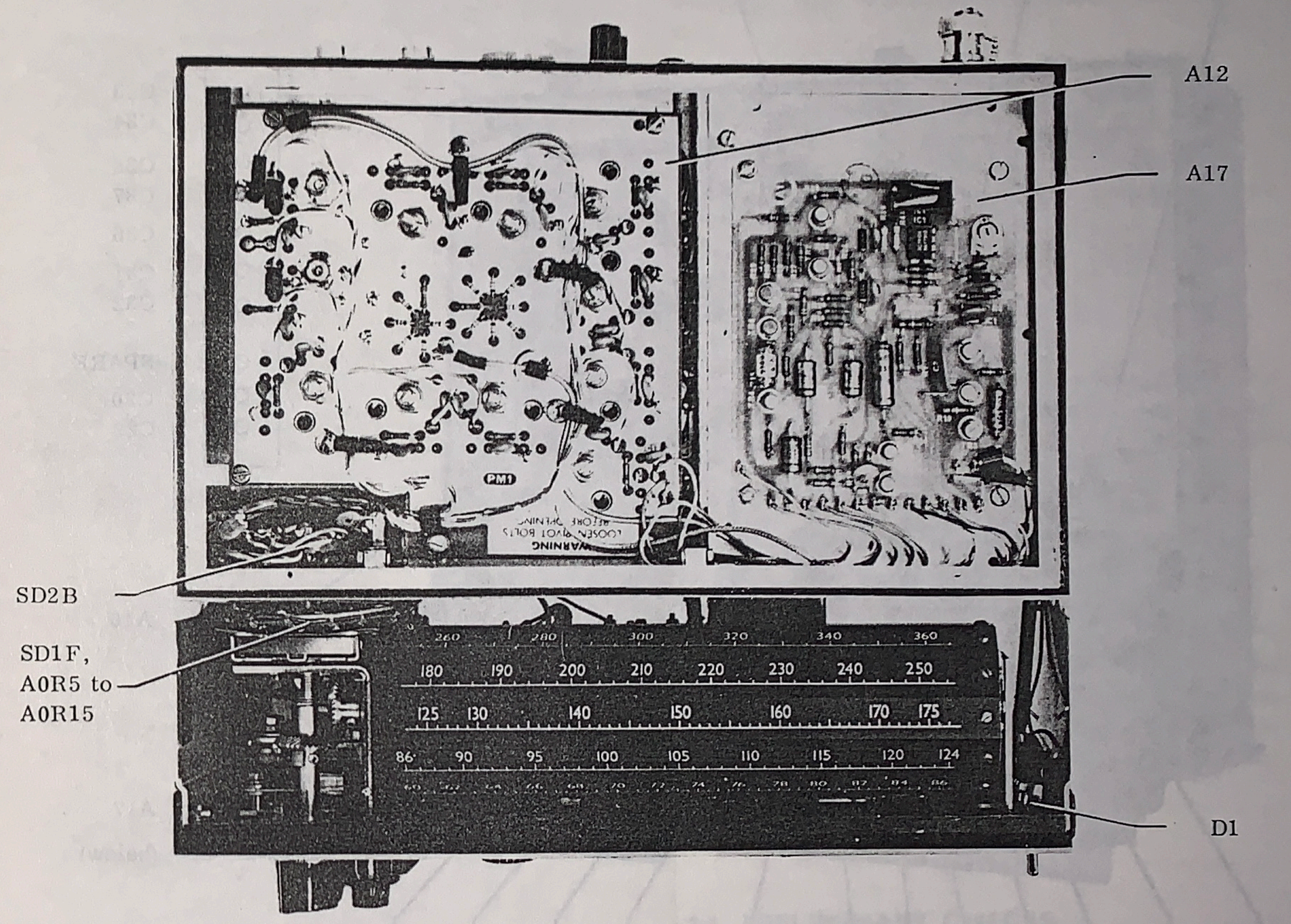


Fig. 4.4 Layout, top view

Table 4.1

Test equipment

Item	Description	Recommended model
a	50 MHz counter	MI TF 2410
b	500 MHz converter	MI TM 8334
c	'N' type 50 Ω load	MI TM 7967
d	Digital voltmeter, up to 50 V with resolution of 1%	MI TF 2670
e	30 MHz oscilloscope	MI TF 2201
f	Wave analyser	MI TF 2330A
g	RF millivoltmeter	MI TF 2603
h	'T' connector	MI TM 7948
i	RF milliwattmeter	MI-Sanders type 6460
j	22 cm air spaced line	General Radio type 874-LO
k	DC microvoltmeter	MI TF 2655
l	Distortion factor meter	MI TF 2331
m	AM/FM modulation meter	MI TF 2300B
n	AF oscillator	MI TF 1101
o	Psophometer	Hatfield Instruments type MBC 1000
p	RF detector	MI TM 9650
q	Short circuit current monitor	- See Fig. 4.5
r	Spectrum analyser	Hewlett Packard type 8554L/8552A/140T
s	Multimeter	GEC Selectest
t	Variable voltage transformer	Variac

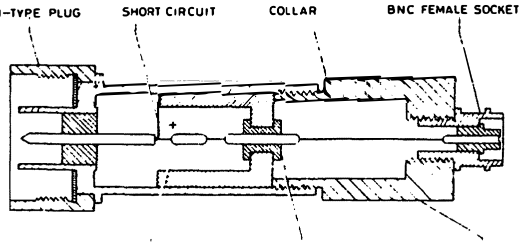


Fig. 4.5 Short circuit load

4.6 PERFORMANCE CHECKS

Many of the methods in this section are simplified and of restricted range compared with those which would be needed to demonstrate complete compliance with the specification. They should be regarded only as providing a check procedure, for use during routine maintenance, to determine whether adjustment or repair is necessary. Any figures given are for guidance only and should not be taken as guaranteed performance figures unless they are quoted in the Data Summary Sect. 1.2.

NOTE. If the results quoted in the following sections are not obtainable, refer to the related section in Chapter 5.

4.6.1 Power supply unit A20

Test equipment : items d, f, t

1. With TF 2015 connected to the a.c. supply and switched on, connect the digital voltmeter between tag 17 (positive) and tag 15 (negative) and check that the meter indicates 22 V ±100 mV. If necessary adjust R4 to obtain this requirement.

2. Connect the digital voltmeter between tag 12 (positive) and tag 15 (negative) and check that the meter indicates 19 V ±100 mV. If necessary, select values for R14 and R17 to obtain this requirement.

3. Apply the a.c. input through a variable voltage transformer and check, using the digital voltmeter, that with inputs to the power supply of between 190 and 260 V the voltage between tag 12 and tag 15 is maintained to within ±40 mV of that obtained in (2).

4. Disconnect the digital voltmeter and with the a.c. input at 230 V connect the wave analyser set for battery operation, in turn to the 22 V and 19 V outputs. The 100 Hz ripple should not be greater than 100 μV r.m.s. and 1 μV r.m.s. at the respective outputs.

5. Disconnect the a.c. supply and connect a 24 V d.c. supply to the battery terminals and check that the 19 V output at tag 12 is within ±100 mV.

Disconnect the d.c. supply and re-connect TF 2015 directly to the a.c. supply.

4.6.2 Frequency calibration unit A12 (sub-assemblies A1 to A11)

Test equipment : items a, b.

1. Set the FUNCTION selector at CW and CARRIER switch at ON then ensure that the pointer of the MOD/CARRIER meter is within the white box on the meter scale.

2. Connect the counter to the COUNTER OUT socket (rear of instrument). Set the CARRIER RANGE selector in turn to ranges 1 to 11 and check, using the TUNE, FINE TUNE and EXTRA FINE TUNE controls, that the scale calibrations at three points on each range i.e. low and high frequency ends and at a centre frequency are within ±1.5% of counter indication.

If necessary, for ranges 1 to 9 inclusive adjust the appropriate core of T1 for low frequency correction and the appropriate capacitor C4 for high frequency correction. Since the core and C4 are interdependent ensure that after the second adjustment the first adjustment remains correct. For ranges 10 or 11 only C4 can be adjusted for high frequency correction. The oscillators are positioned as shown in Fig. 4.1.

4.6.3 RF output (normal)

Test equipment : item i.

1. With the FUNCTION selector and CARRIER switch set as in 4.6.2 (1) connect the power meter to the output of TF 2015.

2. Set the RF OUTPUT controls at 0 and -7 dBm respectively.

3. Verify that the pointer of the MOD/CARRIER LEVEL meter is within the white box. Using the TUNE control to step through each frequency range, verify that the output level is held at -7 dBm ±1 dB up to 100 MHz and within ±2 dB from 100 MHz to 520 MHz.

4. Ensure that when making each check the pointer of the MOD/CARRIER meter remains within the white box.

4.6.4 RF output (+6 dB)

Test equipment : item i.

1. With the FUNCTION selector, CARRIER switch, RF OUTPUT controls, set as in 4.6.2 and with the power meter connected to the RF OUTPUT socket set the frequency of TF 2015 at 100 MHz.

Note the indicated output then set the CARRIER switch at +6 dB and check that the output level has been increased by 6 dB ±1 dB.

2. Repeat the check with TF 2015 tuned to 500 MHz and check that with the CARRIER switch at +6 dB the output level has been increased by 6 dB ±1 dB.

4.6.5 Checking v.s.w.r. (frequencies 350 to 500 MHz)

Test equipment : items j, k, q.

1. Connect the test equipment as in Fig. 4.6.

2. Set the FUNCTION selector at CW, the CARRIER switch at +6 dB, the RF OUTPUT controls at 10 dBm and 7 dBm respectively and the output frequency at 500 MHz.

3. Ensure that the pointer of the MOD/CARRIER meter is within the white box.

4. Set the adjustable line to $\frac{1}{2}\lambda$ (half wavelength) of the signal by applying the formula :

$$\lambda = \frac{300}{f}$$

where λ = wavelength in metres
and f = frequency in MHz

Adjust the line length for a maximum indication on the microvoltmeter and note its reading. Adjust the line length for minimum indication on the microvoltmeter, at $\frac{1}{4}$ wavelength away from the maximum response. Again note the voltmeter reading.

By definition, v. s. w. r. is the ratio of the maximum to minimum line voltage. The r. f. voltage developed across the virtual short circuit is detected by the diode and the corresponding d. c. maximum and minimum (e max and e min) are measured on the microvoltmeter. As the diode is being used on the lowest part of its characteristic a square law voltage applies, the v. s. w. r. being equal to

$$\text{v.s.w.r.} = \sqrt{\frac{\text{e max}}{\text{e min}}}$$

The v. s. w. r. should be better than 1. 3:1

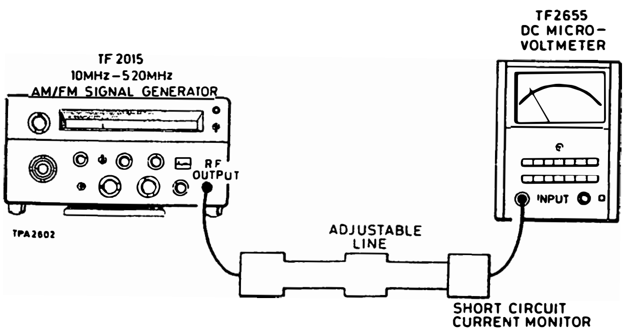


Fig. 4.6 Test gear arrangement to check v.s.w.r.

4.6.6 Checking v.s.w.r. (frequencies 10 to 350 MHz)

Test equipment : items c, g, h.

1. With the TF 2015 controls set as in 4. 6. 2, connect the voltmeter to the RF OUTPUT of TF 2015 using the T connector and note the indicated output level.

2. Connect the 50 Ω load to the T connector and again note the indicated output level.

3. Compute the impedance Z using the following formula :

$$Z = \frac{50E}{V} - 50$$

where E = the open circuit output level
and V = the output across the 50 Ω load.

From the above,

$$\text{v.s.w.r.} = \frac{Z}{50}$$

The v. s. w. r. should be better than 1. 3:1.

4.6.7 Modulation oscillator performance

Test equipment : items a, g, l.

1. Set the FUNCTION selector at INT MOD and the CARRIER switch at OFF.

2. Connect the counter to the INT MOD OUT socket (rear of instrument) and check that the indicated frequency is between 920 Hz and 1080 Hz.

3. Disconnect the counter and connect the distortion factor meter (d. f. m.) to the INT MOD OUT socket.

The measured distortion should not be greater than 0. 25%.

Set the d. f. m. to measure voltage and check that the measured voltage closely approximates 1. 5 V r. m. s.

4.6.8 Checking f.m. deviation

Test equipment : item m.

1. Set the FUNCTION switch at INT FM, set the CARRIER switch at ON, set the frequency of TF 2015 at 20 MHz then adjust SET MOD control to position the pointer of MOD/CARRIER meter at centre of white box on meter scale.

2. Connect the modulation meter tuned to 20 MHz to the RF OUTPUT on TF 2015.

3. Set the DEVIATION controls at x10 and 10 kHz respectively. The measured deviation should be within ±15% of 100 kHz. If necessary adjust SET

MOD to obtain this requirement then reset A18 R5 to position the pointer of the meter at centre of white box.

4. Set the DEVIATION multiplier at x1. The measured deviation should now be within ±15% of 10 kHz. If necessary adjust A19 R12 to obtain this requirement.

4.6.9 Checking a.m. depth

Test equipment : item m or e.

1. Set the FUNCTION selector at INT AM, set the CARRIER switch at ON. Set the frequency of TF 2015 at 20 MHz then adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box.

2. Set the AM DEPTH control at 80%.

3. Connect the modulation meter to the RF OUTPUT on TF 2015. Set the RF OUTPUT controls to provide a suitable input to the modulation meter then tune the modulation meter to TF 2015.

4. Check that the measured a.m. depth is between 70% and 90%.

5. Repeat with the AM DEPTH control at 30% and check that the measured a.m. depth is between 25% and 35%.

If necessary adjust A18 R3 to obtain the best results for both 80% and 30% depths.

NOTE. If a modulation meter is not available the a.m. depth can be assessed by using the oscilloscope to measure the peak and trough values of the modulation envelope. The a.m. depth is then determined by

$$\text{AM depth \%} = \frac{Vp - Vt}{Vp + Vt} \times 100$$

where Vp and Vt are the measured peak-to-peak and trough-to-trough amplitudes respectively.

4.6.10 Checking f.m. tracking

Test equipment : item m.

1. Connect the modulation meter to the RF OUTPUT of TF 2015.

2. Set the FUNCTION selector at INT FM and the CARRIER switch at ON.

3. Adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box. Then set the DEVIATION multiplier at x10 and the deviation control at 10 kHz.

4. Set the CARRIER RANGE selector at 10-14.3 and check that at frequencies 10, 12 and 14 MHz the measured deviation is 100 kHz ±15%.

4.6.11 Checking a.l.c. system

Correct operation of the a.l.c. system can be quickly proved as follows :

1. Set the FUNCTION selector at CW and the CARRIER switch at ON then check that the pointer of the MOD/CARRIER meter is within the white box.

2. Switch to each CARRIER RANGE in turn then use the TUNE control to check that over each frequency range the pointer of the MOD/CARRIER meter remains within the white box.

4.6.12 Counter output level

Test equipment : item i.

1. Set the FUNCTION selector at CW and the CARRIER switch at ON.

2. Connect the power meter to COUNTER OUT socket (rear of instrument) then check that with TF 2015 tuned to 100 MHz the output level is not less than -7 dBm.

4.6.13 External modulation sensitivity

Test equipment : item n.

1. Set the FUNCTION selector at EXT AM and the CARRIER switch at ON:

2. Using the external a.f. generator connected to the EXT MOD IN socket (rear of instrument) check that, with an input signal between 1.2 V and 1.8 V r.m.s. at frequencies of 30 Hz, 1.5 kHz, 10 kHz and 50 kHz, the pointer of the MOD/CARRIER meter can be positioned at the centre of the white box on scale.

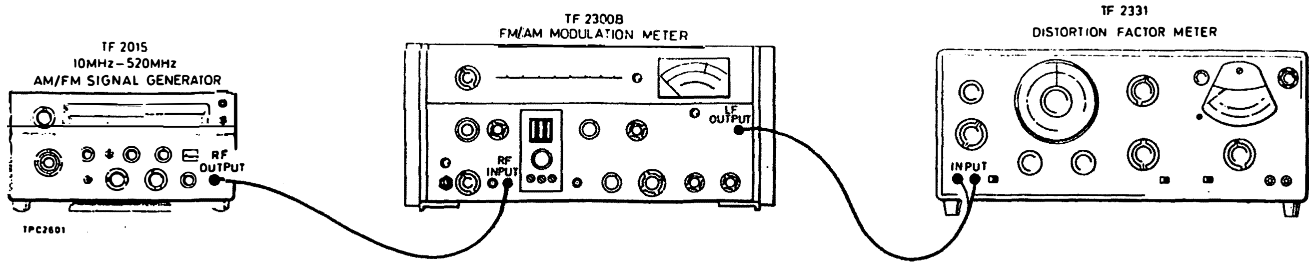


Fig. 4.7 Test gear arrangement to check f.m. and a.m. distortion and f.m. on a.m.

3. Repeat the above with FUNCTION selector at EXT FM.

NOTE. The TF 2015 meter can be overloaded if the applied a.f. input exceeds 10 V.

4.6.14 AM distortion

Test Equipment : items l, m.

1. Connect the test equipment as shown in Fig. 4.7.

2. Set the FUNCTION selector at CW, the CARRIER switch at ON and the frequency of TF 2015 at 100 MHz. Then check that the pointer of the MOD/CARRIER meter is within the white box on meter scale.

3. Set the FUNCTION selector at INT AM. Then adjust SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box on scale.

4. Set the AM DEPTH control at 30%. Then tune the modulation meter to TF 2015 and check that the distortion indicated on the distortion factor meter is not greater than 5%.

5. If required, repeat the check using the external a.f. generator for modulation frequencies at 50 Hz and 20 kHz.

4.6.15 FM distortion

Test equipment : items l, m.

1. With the test equipment connected as in Fig. 4.7 repeat 4.6.14 (2). Then set the FUNCTION selector at INT FM and the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box.

2. Set the DEVIATION multiplier at x10 and the DEVIATION control at 10 kHz.

3. Ensure that the modulation meter is tuned to TF 2015. Then check that the distortion indicated on the distortion factor meter is not greater than 5%.

4. If desired, repeat the check using the external a.f. generator for modulation frequencies at 50 Hz and 20 kHz.

4.6.16 Spurious f.m. on c.w.

Test equipment : items m, o.

1. Connect the test equipment as in Fig. 4.8.

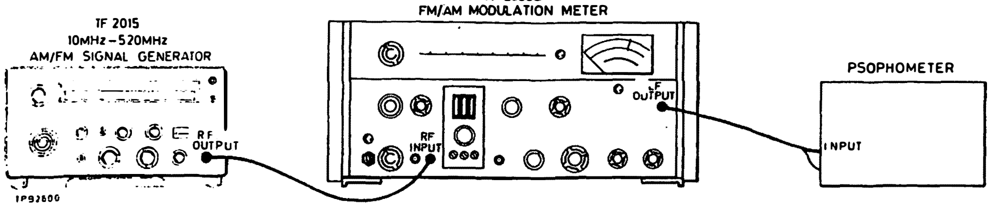


Fig. 4.8 Test gear arrangement to check spurious f.m. on c.w.

2. Set the FUNCTION selector at CW and the CARRIER switch at ON. Then tune TF 2015 to 174.5 MHz and ensure that the pointer of the MOD/CARRIER meter is within the white box.

3. Set the FUNCTION selector at INT FM. Then adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box.

4. Set the DEVIATION multiplier at x1 and the DEVIATION control at 5 kHz.

5. Set the psophometer controls as follows :

INPUT SELECTOR :	Terminated
WEIGHTING :	FILTER NO. 1
ATTENUATOR :	0 dB

6. Using 44 MHz crystal, tune and crystal lock the modulation meter to TF 2015 (modulation meter at 176.0 MHz). Then set the ADJUST CALIBRATION control on the psophometer for a meter indication of 0 dB.

7. Set the FUNCTION selector at CW. Then adjust the psophometer attenuator to restore the meter pointer at 0 dB, and check that the change is greater than 38 dB (less than 61 Hz).

8. If desired repeat the check at a carrier frequency of 481.5 MHz and check that the change is greater than 34 dB (less than 100 Hz).

4.6.17 Spurious a.m. on c.w.

Test equipment : items p, o.

1. Connect the test equipment as shown in Fig. 4.9. Then with the FUNCTION selector at CW, the CARRIER switch at ON and TF 2015 tuned to 100 MHz check that the pointer of the MOD/CARRIER meter is within the white box.

2. Set the FUNCTION selector at INT AM. Then adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box on meter scale.

3. Set the AM DEPTH control at 20% and the TF 2015 output at maximum.

4. Set the Psophometer controls as follows:-

INPUT SELECTOR :	THRO
WEIGHTING :	FILTER NO. 1 (Telephone)
VOLTAGE/dBm RANGE	10 mV

5. Switch the psophometer to INTERNAL SUPPLY. Then adjust the VOLTAGE/dBm RANGE switch and the ADJUST CALIBRATION control for a convenient indication on the meter.

Note the setting of the VOLTAGE/dBm RANGE switch and the meter indication.

6. Set the TF 2015 FUNCTION selector at CW. Then increase the VOLTAGE/dBm RANGE switch on psophometer by 40 dBm. The meter should indicate a level which is less than that noted in 5.

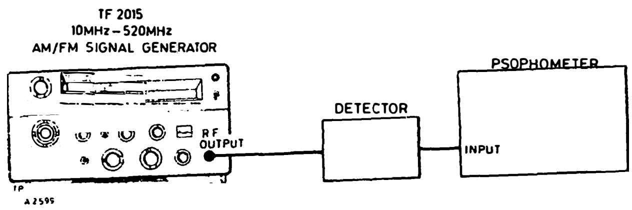


Fig. 4.9 Test gear arrangement to check spurious a.m. on c.w. and a.m. on f.m.

4.6.18 Spurious a.m. on f.m.

Test equipment : items p, o.

1. With the test equipment connected as in Fig. 4.9 repeat 4.6.17 (1) and (2)

2. Set the AM DEPTH control at 30% and the TF 2015 output at maximum.

3. Set the psophometer controls as follows:-

INPUT SELECTOR :	THRO
WEIGHTING :	FILTER NO. 1
VOLTAGE/dBm RANGE :	10 mV

4. Switch the psophometer to INTERNAL SUPPLY. Then adjust the VOLTAGE/dBm RANGE switch and the ADJUST CALIBRATION control for a convenient indication on the meter. Note the setting of the VOLTAGE/dBm RANGE switch and the meter indication.

5. Set the TF 2015 FUNCTION selector at INT FM. Adjust the SET MOD control to position the pointer of the MOD/CARRIER Meter at the centre of the white box. Then set DEVIATION Multiplier at x10 and DEVIATION control at 3(i.e. 30 kHz).

6. Increase the VOLTAGE/dBm RANGE switch on psophometer by 20 dB.
The meter should indicate a level which is not greater than that noted in 4.

4.6.19 Spurious f.m. on a.m.

Test equipment : items l, m.

1. Connect the test equipment as in Fig. 4.7.

2. Set the FUNCTION selector at INT FM, the CARRIER switch at ON, the TF 2015 frequency at 100 MHz and its output at maximum. Then adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box on meter scale.

3. Set the DEVIATION multiplier at x1 and the DEVIATION control at 1 kHz then tune the modulation meter (preferably using crystal lock) to TF 2015 and ensure that the indicated deviation is 1 kHz.

4. Set the FUNCTION selector on the distortion factor meter (d.f.m.) at SET REF LEVEL, the INPUT switch at HI Z, the INPUT range at 1 V - 10 V and the METER RANGE switch at 0.1 V. Then adjust the SET REF (d.f.m.) level control to give a meter indication of 0 dB.

5. Set the TF 2015 FUNCTION selector at INT AM and adjust the SET MOD control to position the pointer of the MOD/CARRIER meter at the centre of the white box. Then set the AM DEPTH control at 30%.

6. Note the difference in level shown on the d.f.m., using a more sensitive range if necessary, and ensure that it is greater than 6 dB, i.e. deviation less than 500 Hz.

$$\left(\text{Deviation in Hz} = \frac{1000}{\text{d.f.m. voltage ratio}}\right)$$

4.6.20 Carrier harmonics

Test equipment : item r.

1. Connect the RF OUTPUT of TF 2015 to the r.f. input of the spectrum analyser.

2. Set the FUNCTION selector at CW, the CARRIER switch at ON and the RF OUTPUT controls fully clockwise. Then ensure that the pointer of the MOD/CARRIER meter is within the white box.

3. Tune TF 2015 through each r.f. range and check that the amplitude of any harmonic is greater than 26 dB down on the fundamental.

4.6.21 Coarse r.f. output control

Test equipment : items i, s.

Provided the attenuator pads have not been damaged (see Sect. 2.4) it is only necessary to prove correct operation of the associated microswitches and this can be satisfied by making a series of resistance measurements as follows :

1. With the SUPPLY switch at OFF, connect the multimeter set at low ohms range to the RF OUTPUT socket.

2. Set both RF OUTPUT controls fully clockwise and check that the multimeter indicates a resistance of 1050 Ω ±2% (resistor tolerance).

3. Position the COARSE control in turn to each dB setting and check that the measured resistance at the 10 dB position is 60 Ω and at 20 dB position 51 Ω and each following position 50 Ω ±2% (resistor tolerance).

4.6.22 Fine r.f. output control

Test equipment : items i, s.

1. Connect the power meter to the RF OUTPUT socket.

2. Set the SUPPLY switch at ON, the FUNCTION selection at CW, the CARRIER switch at ON. Tune TF 2015 to 100 MHz and check that the pointer of the MOD/CARRIER meter is within the white box.

3. Set the COARSE control at 0 and the FINE control at -7 dBm then note the reading obtained on the power meter.

4. Repeat check 3 with the FINE control in turn at 9, 11, 13, 15, 17 dBm.

4.7 CLEANING ROTARY SWITCHES

If it is necessary to clean the contacts of any rotary switches, this should be done with benzine or white spirit (not carbon tetrachloride) and the contacts should afterwards be wiped with a suitable lubricant such as a 1% solution of petroleum jelly in white spirit. Avoid lubricants containing soap or solid materials.

Chapter 5

Repair

5.1 INTRODUCTION

Since the functional checks given in Chapter 4 serve to localize the cause of incorrect performance of the instrument, this chapter is intended to assist in tracing the fault to the particular part of the suspect circuit.

The information given, should be read with reference to Chapter 3 and 4 and the circuit diagrams contained within this manual.

5.2 FAULT LOCATION

Some aid to fault finding is provided by the typical d. c. voltage and signal levels given in Sections 5.2.1, 5.2.2, 5.2.3 and by the fault tables included in each of the following sections. The tables are not extensive but are intended as a pointer to further investigation. It is to be emphasized that each fault table should be studied having regard for the others since incorrect operation of a circuit may be caused by malfunction of an associated circuit.

5.2.1. D.C. Voltages

Test equipment : item s.

Voltages given on the circuit diagrams and in Tables 5.1 and 5.2 approximate those which can be expected using a 20 kΩ/V meter on a typical TF 2015 connected to an a.c. supply of 240 V, 50 Hz and unless stated otherwise were measured with the controls of TF 2015 positioned as follows :

CARRIER FREQUENCY :	at 14 MHz RANGE 1
CARRIER switch :	at ON
FUNCTION selector :	at INT AM
RF OUTPUT controls :	at 0 and -7 dBm

Prior to making measurements ensure that screws on Unit A12 are tight.

Voltage levels at A12 pin 12 are dictated by the a.l.c. voltage at A17 pin 5 and should approximate those given in Table 5.1.

Table 5.1

Range TF 2015	*Frequency MHz*	*Voltage (V d.c.) at A12 pin 12*
1-7	10 - 124	9-11
8	124	8.6
	177	9.7
9	177	9.2
	250	9.8
10	250	4.3
	320	8.0
	360	6.5
11	360	7.0
	410	9.2
	520	8.3

Voltage levels on Unit A23 which were measured with TF 2015 set in turn at 10 MHz and 14 MHz (RANGE 1) with CARRIER switch at ON and f.m. at 100 kHz deviation should approximate those given in Table 5.2.

Table 5.2

Test point	*Voltage (V d.c.) 10 MHz*	*Voltage (V d.c.) 14 MHz*	*Meter range (V)*	*Remarks*
Junction R1/D1	4.7	7.5	100	
Junction C2/D1	0	7.5	100	
Junction R4/D2	0.2	0.25	2.5	negative with respect to chassis
Junction R2/D2	0.03	0.03	2.5	

5.2.2. R.F. Signal levels

Test equipment : item g.

The r.f. signal levels listed in Table 5.3 approximate those which can be expected using the specified meter on a typical TF 2015 connected to an a.c. supply of 240 V, 50 Hz.

Measurements were made with the TF 2015 FUNCTION selector at CW, the RF OUTPUT controls at 0 and -7 dBm and with the earth probe of TF 2603 connected to a position on the earth track on the printed board close to the test point.

Table 5.3

Unit	*Test point*	*Range 1* Signal level (mV) 14 MHz, Carrier switch *On*	*Range 1* Signal level (mV) 14 MHz, Carrier switch *+6dB*	*Range 11* Signal level (mV) 520 MHz, Carrier switch *On*	*Range 11* Signal level (mV) 520 MHz, Carrier switch *+6dB*
A12	Pin 14	54	-	69	-
A16	Pin 1	53	-	24	-
	Junction R2/R4	9	-	28	-
	TR1e	2	-	1.8	-
	TR1c	20	-	28	-
	TR2c	140	-	145	-
	TR3e	7	-	46	-
	TR3c	37	-	38	-
	TR4c	330	-	230	-
	Junction D3/D5	175	180	94	65
	Junction D3/D4	23	67	27	125
	Junction D4/D6	170	180	103	158
	Junction D5/D6	24	68	31	118
	Junction C19/T2	45	125	15.5	77
	TR5b	5.5	11	20	90
	TR5c	80	260	84	310
	TR7b	6.2	13.5	37	81
	TR7c	105	210		205
	TR8b	9.4	19.5	96	200
	TR8c	205*	400	265*	490
	TR6b	67*	-	38*	-
	TR6c	690*	-	155*	-
	Pin 7	2ø	2.5ø	8.5ø	24ø

* SKF (COUNTER OUTPUT) loaded with 50 Ω.

ø Spurious r.f. levels present on the +22 V d.c. line measured with TF 2603 earth probe connected to earth track on printed board and close to TR8.

5.2.3. A.F. Signal levels

Test equipment : item c.

The a.f. signal levels listed in Table 5.4. approximate those which can be expected on a typical TF 2015 connected to an a.c. supply of 240 V, 50 Hz.

Unless stated otherwise, measurements were made with TF 2015 set at 14 MHz RANGE 1 and CARRIER switch at ON.

Table 5.4

Unit	*Control settings*	*Test point*	*Signal level*	*Remarks*
A19	FUNCTION - INT FM	Pin 3	6.7 V p-p	
	DEVIATION - 100 kHz	Pin 7	3.2 V p-p	negative peak compressed
		Pin 18	6.4 V p-p	
		Pin 17	1 V p-p	negative peak compressed
		Pin 9	3 V p-p	
A21	FUNCTION - INT FM	Pin 15	0.5 V p-p	
	DEVIATION - 100 kHz	Pin 13	205 mV p-p	carrier frequency 10 MHz
A21	FUNCTION - INT AM	Pin 6	850 mV p-p	
	AM DEPTH - 80%	Pin 8	58 mV p-p	negative peak compressed
		Pin 9	70 mV p-p	negative peak compressed

5.2.4 Power supply

Circuit diagram Fig. 7.4 Unit A20

Table 5.5

Fault	*Probable cause*
(a) Fuse FS1 or FS3 blows when instrument is switched on.	Short in a.c. input circuit. A0 C1 or C2 short-or partial short-circuit.
(b) No 22 V output	A0 TR1 open-circuit (check 22 V line for short) A0 C1, C2 or C5 short-or partial short-circuit.
(c) No 19 V output	TR4 open-circuit (check 19 V line for short).
(d) Inability to set 22 V ±100 mV.	TR2, TR3 or TR5 faulty. Resistor open-circuit or value changed. C3 or C4 short-or partial short-circuit.
(e) Incorrect 19 V ±100 mV output.	Faulty TR5, TR6, TR8 Resistor open circuit or value changed especially R9, R14 or R17.
(f) 100 Hz supply on 22 V line greater than 100 μV r.m.s.	A0 C1, C2 or C3 open-circuit or low capacitance. D1, D2, D3 or D4 faulty.
(g) 100 Hz supply on 19 V line greater than 1 μV r.m.s.	C8 open circuit or low capacitance.

5.2.5 RF calibrations

Circuit diagram Fig. 7.1 Unit A12 (sub-assemblies A1 to A11)

Table 5.6

Fault	*Probable cause*
(a) Calibrations incorrect all ranges.	Incorrect d.c. voltage at A19 pin 8 (Fig. 7.3). Check d.c. path to switch SG (Fig. 7.3).
(b) Inability to set scale calibrations on any selected range.	Incorrect d.c. voltage to R4 (A1 to A9) R5 (A10 and A11). Check output A21 pin 13. Faulty varactor D1 or D2.

5.2.6 RF output (normal)

Circuit diagram Fig. 7.2 Units A16, A17, A18

Table 5.7

Fault	*Probable cause*
Meter pointer not within white box	Incorrect d.c. outputs A18 pins 12 or 13. Check circuit A18 TR2. Faulty resistor or diode in circuit A18 R13 to R21, D4 or D5. Incorrect operation of circuit A17, R1 to R7, TR1, TR2 or TR3. DC offsets to A16 modulator from A17 TR7 and TR8 at incorrect level. Check circuit TR7 and TR8. Fault in amplifier circuit A16 TR5, TR7 and TR8. D7 or D8 faulty. Fault in a d.c. circuit of A17. Check TR9, TR10, IC1 and A16 D9 and D10.

5.2.7 RF output (+6 dB)

Table 5.8

Fault	*Probable cause*
+6dB output not obtainable	Faulty carrier switch. Faulty diode A18 D6 or R25. Recheck operation of circuits A17 TR7, TR8 for increased d.c. offsets to A16 modulator and operation of a.l.c. loop with carrier switch at +6dB.

5.2.8 VSWR

Check that A16 R39 is $50\ \Omega \pm 1\%$ and recheck A22 as given in Sect. 4.6.21.

5.2.9 Modulation oscillator

Circuit diagram Fig. 7.3 Unit A19

Table 5.9

Fault	*Probable cause*
(a) No output or incorrect output	No 22 V at pin 1: check switch SA1F TR1 or TR2 faulty.
(b) Frequency incorrect	R1, R2, C1 or C2 faulty; check values.
(c) Distortion greater than 0.25%	Faulty thermistor R7. Check C3, C4.

5.2.10 Amplitude modulation

Circuit diagram Figs. 7.2 and 7.3 Units A16, A17, A18

Table 5.10

Fault	*Probable cause*
(a) Inability to set meter pointer at centre of white box by adjusting SET MOD control.	A0R2 faulty. Fault in monitor circuit A18 TR1.
(b) Inability to obtain required modulation depth.	Fault in a.m. driver circuit A17 TR4, TR5 or TR6. Incorrect operation of modulator : check A16 D3 to D6, L1 and L2. Check A16 C17, C18 and a.f. path from SET MOD control to driver.
(c) Envelope distortion	Fault in modulation oscillator. Fault in a. m. driver circuit.

5.2.11 Frequency modulation

Circuit diagram Figs. 7.2 and 7.3 Units A19 and A23

Table 5.11

Fault	*Probable cause*
No frequency modulation.	Check a.f. path from SET MOD control to A23. Incorrect operation of circuits A19 or A23. Switch SG faulty.
Incorrect deviation	Faulty resistor A0 R5 to R15, A19 R18 to R22 or R17.
FM distortion	Incorrect operation of circuits A19 or A23.

5.2.12 ALC system

Circuit diagram Fig. 7.2 Units A16, A17, A18

Table 5.12

Fault	*Probable cause*
Meter pointer at zero or full scale - all ranges.	Fault in r.f. signal path. Check outputs from circuits on A16. Fault in circuit A17 TR7. TR8. Fault in circuit A17 TR9, TR10. IC1. Fault in circuit A18 TR2 : check outputs. Check diodes D4, D5 and associated resistors.
- on one range only.	No input to A16 pin 1 : suspect appropriate oscillator output.

5.2.13 Carrier harmonics

Circuit diagram Fig. 7.2 Units A16 and A17

Table 5.13

Fault	*Probable cause*
Amplitude too high - all ranges.	Incorrect operation of first a.l.c. loop, causing high oscillator outputs to overload pre-amplifier. Amplifier distortion: check circuits TR1 to TR4 and TR5, TR7 and TR8.

5.2.14 Spurious modulation

Table 5.14

Fault	*Probable cause*
Spurious f.m. or a.m. too high.	Excess ripple on 22 V or 19 V d.c. supplies or increased circuit noise. Check transistors, diodes, and if necessary resistors especially those incorporated in a.l.c. loops.

5.3 REPLACING TUNING DRIVE CORD

Drive cord : 1 metre nylon cord MI code No. 16410 - 604.
Tension spring : MI code No. 31119-017.
To gain access to the drive cord assembly proceed as follows.

(1) Remove the case from the instrument and remove the attenuator unit (see Sect. 4.3).

(2) Remove the scale plates for the three highest frequency ranges.

(3) Set the RANGE switch to the 14.3 - 20.5 MHz position.

(4) Stand the instrument upside-down on the bench.

(5) Referring to Fig. 5.1, slacken the grub screws and unscrew the nut to pull aside R38. With the TUNE control three steps away from the fully counter-clockwise position, slacken one of the grub screws in the cord-drum boss.

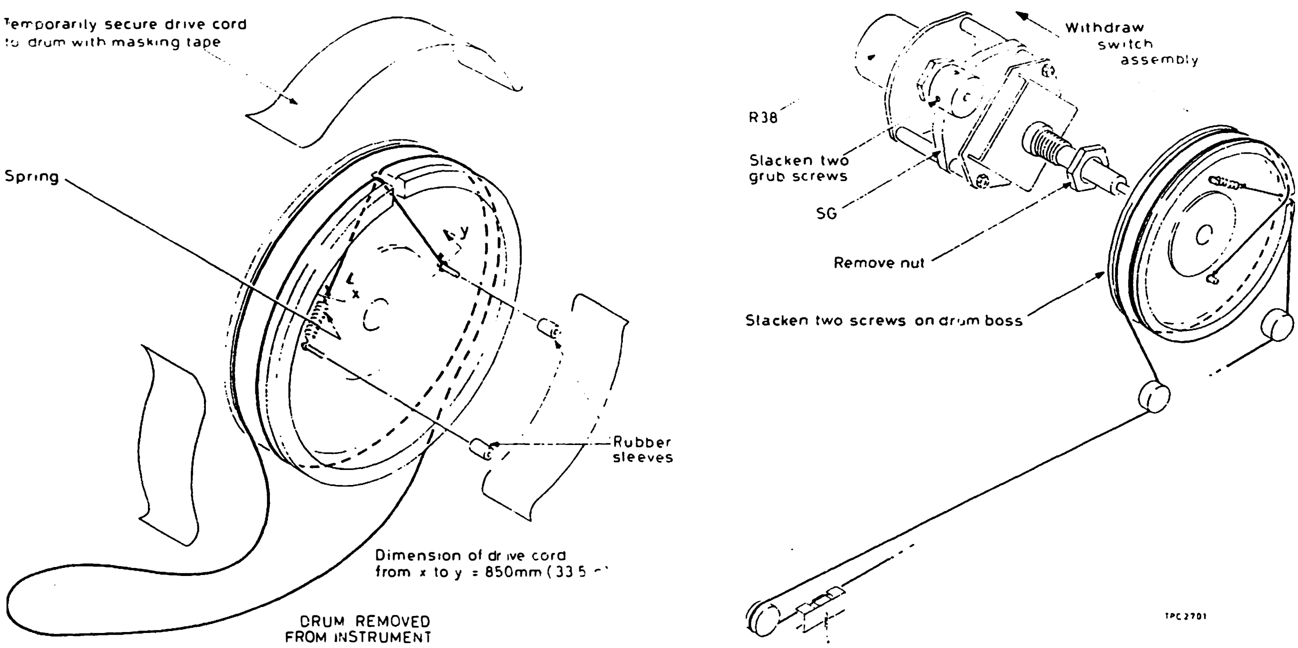


Fig. 5.1 Replacing cord drive

Turn the TUNE control fully clockwise and slacken the other grub screw. Remove the TUNE and EXTRA FINE TUNE knobs. Unscrew the nut and pull away the switch assembly SG from the drum.

(6) Remove the drum and attach the drive cord as shown in Fig. 5.1, temporarily holding it in place with adhesive tape. Seal the cord knots with bakelite varnish.

(7) Replace the drum and completely refit the switch SG and R38 assemblies.

(8) Fit the loop of cord around the three pulleys. Check that the cord spring is under tension. If the cord has been properly dimensioned, the expanded length of the spring will be about 12 mm ($\frac{1}{2}$ inch). Refit the knobs.

(9) Attach the pointer to the drive cord and adjust its position so that it reaches (or just passes) the 60 MHz and 124 MHz calibration marks :

(a) On 60 - 86 MHz range with both TUNE and FINE TUNE controls fully counter-clockwise.

(b) On 86 - 124 MHz range with both TUNE and FINE TUNE controls fully clockwise.

(10) Refit scale plates, attenuator unit and case.

5.4 REPLACING TRANSFORMERS A16 T1 T2

If modulator transformers T1 or T2 are required to be replaced it is important that the replacement be connected, in the same way as the removed component. The required connections are shown in Fig. 5.2

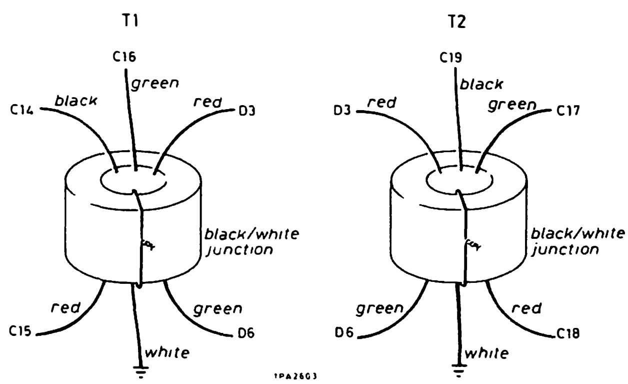


Fig. 5.2

5.5 ADDITIONAL INFORMATION

If further information is required please write or telephone Marconi Instruments Limited, Service Division - see address on back cover - or contact nearest representative, quoting the type and serial number on the data plate on rear of instrument.

If the instrument is being returned for repair please indicate clearly the nature of the fault or the work you require to be done.

Chapter 6 Replaceable parts

Introduction

Each sub-assembly or printed circuit board in this instrument has been allocated a unit identification in the sequence A0 to A12 and A16 to A23.

The complete component reference carries its unit number as a prefix e.g. A1C1 but for convenience in the text and on circuit diagrams the prefix is not used.

However, when ordering replacements or in correspondence the complete component reference must be quoted.

One or more of the components fitted in this instrument may differ from those listed in this chapter for any of the following reasons:

(a) Components indicated by † have their value selected during test to achieve particular performance limits.

(b) Owing to supply difficulties, components of different value or type may be substituted provided the overall performance of the instrument is maintained.

(c) As part of a policy of continuous development, components may be changed in value or type to obtain detail improvements in performance.

When there is a difference between the component fitted and the one listed, always use as a replacement the same type and value as found in the instrument.

Ordering

When ordering replacements, address the order to our Service Division (address on rear cover) or nearest agent and specify the following for each component required.

(1) Type* and serial number of instrument

(2) Complete circuit reference

(3) Description

(4) MI code number

* as given on the serial number label at the rear of the instrument; if this is superseded by a model number label, quote the model number instead of the type number.

Component references

The components are listed in alpha-numerical order and the following abbreviations are used:

C	:	capacitor
Carb	:	carbon
Cer	:	ceramic
Cerm	:	cermet
D	:	semiconductor diode
Elec	:	electrolytic
FS	:	fuse
IC	:	integrated circuit (package)
L	:	inductor
Max	:	maximum
ME	:	meter
Met	:	metal
Mic	:	mica
Min	:	minimum value
Ox	:	oxide
PL	:	plug
Plas	:	plastic dielectric
R	:	resistor
S	:	switch
SK	:	socket
T	:	transformer
TP	:	terminal
TR	:	transistor
WW	:	wirewound
X	:	crystal oscillator
†	:	value selected during test; nominal value listed
Ø	:	feed-through component
W	:	watts at 70°C

TUNING DIODES

When ordering replacement diodes D1 and D2 for oscillator units A1 to A11 it is necessary to ensure that diodes of the correct voltage/capacitance characteristic are supplied by following the instructions given below.

For instruments with serial numbers 116903/01 and onwards there is a label on Unit A12 bearing a letter and a number to identify the particular group of diodes used. To obtain the correct replacement you order should call for :

(i) Type and serial number of instrument.
(ii) Complete circuit reference e.g. A1D2.

(iii) Description, i.e. Diode BB105A.
(iv) MI code number 44529-003 plus Group identification code e.g. 44529-003/D3.

DETECTOR DIODES

Older instruments with serial numbers 116904/100 onwards may be fitted with either diodes type CG92H or HP5082-2835 matched pairs in Units A16 and A17. These may be replaced by the diodes specified for the current production series, i.e. serial numbers 116970 onwards. The diodes now fitted require no special selection and may be ordered as direct replacements. Units A16 and A17 D1, D2 are fitted with type HP 5082-2811 Code No. 28349-008. Unit A16 D9, D10 and Unit A17 D4, D5 are fitted with HP 5082-2835 Code No. 28349-006.

Circuit reference	*Description*	*M.I. code*

Unit (A0)

When ordering, prefix circuit reference with A0

C1	Elec 2200μF +50-10% 40V	26426-086
C2 to C25	Cer Ø 0.001μF +80-20% 300V	26373-733
C26	Cer Ø 50pF 10% 300V	26333-229
C27	Cer Ø 50pF 10% 300V	26333-229
C28	Cer Ø 50pF 10% 300V	26333-229
C29 to C35	Cer Ø 500pF +80-20% 300V	26373-732
C36	Cer Ø 50pF 10% 300V	26333-229
C37	Cer Ø 500pF +80-20% 300V	26373-732
C38 †	Elec 22μF ±20% 15V	26486-583
D1	LED (On-Off indicator)	28624-103
FS1 & FS3	160 mA slow-blow (190-264 V)	23411-054
or	250 mA slow-blow (95-132 V)	23411-055
	Holder for FS1, FS2 & FS3	23416-191
	Cover for FS1 & FS3	23416-198
FS2	500mA slow-blow	23411-056
L1	Choke 100μH	23642-561
L2	Choke 100μH	23642-561
L3	Choke 100μH	23642-561
L4	Choke 100μH	23642-561
L5	Choke 100μH	23642-561
L6	Choke 100μH	23642-561
L7	Choke 100μH	23642-561
L8	Choke 100μH	23642-561
L9	Choke 100μH	23642-561
L10	Choke 100μH	23642-561
L11	Choke 10μH	23642-555
L12	Choke 10μH	23642-555
L13	Choke 100μH	23642-561
L14	Choke 100)H	23642-561
L15	Choke 10μH	23642-555

Circuit reference	Description	M.I. code
L16	Choke 10μH	23642-555
L17	Choke 100μH	49116-909
L18	Choke 100μH	49116-909
ME1	Meter	44559-011
R1	Cerm 1kΩ 10% 2W	25725-403
R2	Cerm 1kΩ 10% 2W	25725-403
R3	Met film 1kΩ 2% ¼W	24773-273
R4	Cerm 1kΩ 10% 2W	25725-403
R5	Met film 2.2kΩ 2% ¼W	24773-281
R6	Met film 1.5kΩ 2% ¼W	24773-277
R7	Met film 1.1kΩ 2% ¼W	24773-274
R8	Met film 750Ω 2% ¼W	24773-270
R9	Met film 510Ω 2% ¼W	24773-266
R10	Met film 360Ω 2% ¼W	24773-262
R11	Met film 240Ω 2% ¼W	24773-258
R12	Met film 180Ω 2% ¼W	24773-255
R13	Met film 120Ω 2% ¼W	24773-251
R14	Met film 130Ω 2% ¼W	24773-252
R15	Met film 150Ω 2% ¼W	24773-253
R5 to R15 (inclusive) mounted on RANGE switch SD		
R16	Cerm 10kΩ 10% 2W	25725-404
R17	Met film 1.1kΩ 2% ¼W	24773-274
R18	Met film 750Ω 2% ¼W	24773-270
R19	Met film 680Ω 2% ¼W	24773-269
R20	Met film 560Ω 2% ¼W	24773-267
R21	Met film 510Ω 2% ¼W	24773-266
R22	Met film 430Ω 2% ¼W	24773-264
R23	Met film 430Ω 2% ¼W	24773-264
R24	Met film 390Ω 2% ¼W	24773-263
R25	Met film 360Ω 2% ¼W	24773-262
R26	Met film 330Ω 2% ¼W	24773-261
R27	Met film 300Ω 2% ¼W	24773-260
R28	Met film 300Ω 2% ¼W	24773-260
R29	Met film 240Ω 2% ¼W	24773-258
R30	Met film 220Ω 2% ¼W	24773-257

Circuit reference	Description	M.I. code
R31	Met film 200Ω 2% ¼W	24773-256
R32	Met film 180Ω 2% ¼W	24773-255
R33	Met film 160Ω 2% ¼W	24773-254
R34	Met film 130Ω 2% ¼W	24773-252
R35	Met film 120Ω 2% ¼W	24773-251
R36	Met film 100Ω 2% ¼W	24773-249
R17 to R36 (inclusive) mounted on TUNE switch SG		
R37	WW 100kΩ 10% 10-turn 0.8W	25885-031
R38	WW 10kΩ 10% ½W	25812-696
R39	Met film 50Ω 1% ¼W	24762-558
R40	Met film 200Ω 2% ¼W	24773-256
R41	Met film 820Ω 2% ¼W	24773-271
R42 †	Met film 2.2kΩ 2% ¼W	24773-281
R43	Met film 470Ω 2% ¼W	24773-265
SA	Function switch	44340-022
SB	Carrier switch 4-pole 3-pos.	23462-267
SC	Deviation multiplier switch SPDT	23462-252
SD1	Front wafer of carrier range switch	44340-031
SD2	Rear wafer of carrier range switch	44340-030
SE	Supply switch DPDT	23462-258
SF	Voltage selector switch 230V/115V	23467-155
SG	Tune switch	44340-015
SKA	Bulgin P580	23423-159
SKB	BNC 50Ω (Ext mod in)	23443-443
SKC	BNC 50Ω (Int mod out)	23443-443
SKD	BNC 50Ω (Sync in)	23443-443
SKE	DIN speaker type (IF probe supply)	23435-252
SKF	TNC 50Ω (counter out)	23444-741
SKH	BNC 50Ω (RF out)	43129-029
T1	Mains transformer	43490-010
TP1	Battery terminal + input	23235-176
TP2	Battery terminal - input	23235-176

For symbols and abbreviations see introduction to this chapter

Circuit reference		Description	M.I. code
TR1		Transistor 2N3055	28456-567
X1 to X40		Ferrite bead	41372-006

Unit (A1) oscillator range 1

When ordering, prefix circuit reference with A1

C1		Cer 0.01μF +80-20% 100V	26383-055
C2	†	Cer 10pF ±0.5pF 500V	26343-121
C3		Cer 220pF 20% 500V	26383-134
C4		Cer var. 0.5 - 5pF	26845-141
D1		Tuning varactor BB105A	See p.41 tuning diodes
D2		Tuning varactor BB105A	
R1		Met film 300kΩ 2% $\frac{1}{4}$W	24773-321
R2		Met film 300kΩ 2% $\frac{1}{4}$W	24773-321
R3		Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R4		Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R5		Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R6	†	Met film 22kΩ 2% $\frac{1}{4}$W	24773-305
T1		Coil assembly	44290-079
TR1		Transistor WN428	28459-025

Unit (A2) oscillator range 2

When ordering, prefix circuit reference with A2

C1		Cer 0.01μF +80-20% 100V	26383-055
C2	†	12pF 10% 500V	26343-125
C3		Cer 220pF 20% 500V	26383-134
C4		Cer var. 0.5 - 5pF	26845-141
D1		Tuning varactor BB105A	See p.41 tuning diodes
D2		Tuning varactor BB105A	
R1		Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R2		Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R3		Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R4		Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R5		Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R6	†	Met film 22kΩ 2% $\frac{1}{4}$W	24773-305
T1		Coil assembly	44290-080
TR1		Transistor WN428	28459-025

Unit (A3) oscillator range 3

When ordering, prefix circuit reference with A3

C1		Cer 0.01μF +80-20% 100V	26385-055
C2	†	Cer 15pF ±0.5pF 500V	26343-127
C3		Cer 220pF 20% 500V	26383-134
C4		Cer var. 0.5 - 5pF	26845-141
D1		Tuning varactor BB105A	See p.41 tuning diodes
D2		Tuning varactor BB105A	
R1		Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R2		Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R3		Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R4		Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R5		Met film 100Ω 2% $\frac{1}{4}$W	24773-249
T1		Coil assembly	44290-081
TR1		Transistor WN428	28459-025

Unit (A4) oscillator range 4

When ordering, prefix circuit reference with A4

C1		Cer 0.001μF +80-20% 500V	26383-242
C2	†	Cer 10pF ±0.5pF 500V	26343-121
C3		Cer 220pF 20% 500V	26383-134
C4		Cer var. 0.5 - 5pF	26845-141
D1		Tuning varactor BB105A	See p.41 tuning diodes
D2		Tuning varactor BB105A	

For symbols and abbreviations see introduction to this chapter

Circuit reference		Description	M.I. code
R1		Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R2		Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R3		Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R4		Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R5		Met film 100Ω 2% $\frac{1}{4}$W	24773-249
T1		Coil assembly	44290-082
TR1		Transistor WN428	28459-025

Unit (A5) oscillator range 5

When ordering, prefix circuit reference with A5

Circuit reference		Description	M.I. code
C1		Cer 0.001μF +80-20% 500V	26383-242
C2	†	Cer 10pF ±0.5pF 500V	26343-121
C3		Cer 220pF 20% 500V	26383-134
C4		Cer var. 0.5 - 5pF	26845-141
D1		Tuning varactor BB105A	See p.41 tuning diodes
D2		Tuning varactor BB105A	
R1		Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R2		Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R3		Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R4		Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R5		Met film 100Ω 2% $\frac{1}{4}$W	24773-249
T1		Coil assembly	44290-083
TR1		Transistor WN428	28459-025

Unit (A6) oscillator range 6

When ordering, prefix circuit reference with A6

Circuit reference		Description	M.I. code
C1		Cer 0.001μF +80-20% 500V	26383-242
C2	†	Cer 7.5pF ±0.5pF 500V	26343-117
C3		Cer 220pF 20% 500V	26383-134
C4		Cer var. 0.5 - 5pF	26845-141
D1		Tuning varactor BB105A	See p.41 tuning diodes
D2		Tuning varactor BB105A	
R1		Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R2		Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R3		Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R4		Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R5		Met film 100Ω 2% $\frac{1}{4}$W	24773-249
T1		Coil assembly	44290-084
TR1		Transistor WN428	28459-025

Unit (A7) oscillator range 7

When ordering, prefix circuit reference with A7

Circuit reference		Description	M.I. code
C1		Cer 680pF +40-20% 500V	26383-141
C2	†	Cer 7.5pF ±0.5pF 500V	26343-117
C3		Cer 220pF 20% 500V	26383-134
C4		Cer var. 0.5 - 5pF	26845-141
D1		Tuning varactor BB105A	See p.41 tuning diodes
D2		Tuning varactor BB105A	
R1		Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R2		Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R3		Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R4		Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R5		Met film 100Ω 2% $\frac{1}{4}$W	24773-249
T1		Coil assembly	44290-085
TR1		Transistor WN428	28459-025

For symbols and abbreviations see introduction to this chapter

Unit (A8) oscillator range 8

When ordering, prefix circuit reference with A8

Circuit reference	Description	M.I. code
C1	Cer 470pF +40–20% 500V	26383-139
C2 †	Cer 12pF 10% 500V	26343-125
C3	Cer 220pF 20% 500V	26383-134
C4	Cer var. 0.5 - 5pF	26845-141
D1	Tuning varactor BB105A	See p.41 tuning diodes
D2	Tuning varactor BB105A	
R1	Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R2	Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R3	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R4	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R5	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
T1	Coil assembly	44290-086
TR1	Transistor WN428	28459-025

Unit (A9) oscillator range 9

When ordering, prefix circuit reference with A9

Circuit reference	Description	M.I. code
C1	Cer 330pF 20% 500V	26383-136
C2 †	Cer 10pF ±0.5pF 500V	26343-121
C3	Cer 220pF 20% 500V	26383-134
C4	Cer var. 0.5 - 5pF	26845-141
D1	Tuning varactor BB105A	See p.41 tuning diodes
D2	Tuning varactor BB105A	
R1	Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R2	Met film 300kΩ 2% $\frac{1}{4}$W	24773-332
R3	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R4	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R5	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
T1	Coil assembly	44290-087
TR1	Transistor WN428	28459-025

Unit (A10) oscillator range 10

When ordering, prefix circuit reference with A10

Circuit reference	Description	M.I. code
C1	Cer 220pF 20% 500V	26383-134
C2	Cer 2.2pF ±0.5% 500V	26343-110
C3	Cer 100pF 20% 500V	26343-167
C4	Cer var. 0.5 - 5pF	26845-141
C5	Cer 68pF 20% 500V	26343-163
C6	Cer 2.2pF ±0.25% 750 V	26324-011
D1	Tuning varactor BB105A	See p.41 tuning diodes
D2	Tuning varactor BB105A	
D3	Diode 1N4148	28336-076
R1	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289
R2	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R3	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R4	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281
R5	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R6	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R7	Carb 22Ω 5% $\frac{1}{4}$W	24312-788
L1	Oscillator inductor	
TR1	Transistor BFR90	28452-167

Unit (A11) oscillator range 11

When ordering, prefix circuit reference with A11

Circuit reference	Description	M.I. code
C1	Cer 100pF 20% 500V	26343-167
C2 †	Cer 47pF 20% 500V	26343-113
C3	Cer 100pF 20% 500V	26343-167
C4	Cer var. 0.5 - 5pF	26845-141
C5	Cer 68pF 20% 500V	26343-163

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
D1	Tuning varactor BB105A	See p.41 tuning diodes
D2	Tuning varactor BB105A	
R1	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289
R2	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R3	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R4	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R5	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R6	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R7	Carb 22Ω 5% $\frac{1}{4}$W	24312-788
L1	Oscillator inductor	-
TR1	Transistor BFR90	28452-167

Unit A12 mother board

When ordering, prefix circuit reference with A12

Circuit reference	Description	M.I. code
C1	Cer 0.01μF +80-20% 100V	26383-055
C2	Cer 0.01μF +80-20% 100V	26383-055
C3	Cer 0.01μF +80-20% 100V	26383-055
C4	Cer 0.001μF +80-20% 500V	26383-242
C5	Cer 0.001μF +80-20% 500V	26383-242
C6	Cer 0.001μF +80-20% 500V	26383-242
C7	Cer 0.001μF +80-20% 500V	26383-242
C8	Cer 100pF 20% 500V	26343-167
C9	Cer 68pF 20% 500V	26343-163
C10	Cer 470pF +40-20% 500V	26383-139
C11	Cer 100pF 20% 500V	26343-167
C12	Cer 0.01μF +80-20% 100V	26383-055
C13	Cer 0.01μF +80-20% 100V	26383-055
C14	Cer 0.001μF +80-20% 500V	26383-242
C15	Cer 0.001μF +80-20% 500V	26383-242
C16	Cer 0.001μF +80-20% 500V	26383-242
C17	Cer 0.001μF +80-20% 500V	26383-242
C18	Cer 0.001μF +80-20% 500V	26383-242
C19	Cer 470pF +40-20% 500V	26383-139
C20	Cer 470pF +40-20% 500V	26383-139
D1	Diode 1N3062	28336-248
D2	Diode 1N3062	28336-248
D3	Diode 1N3062	28336-248
D4	Diode 1N3062	28336-248
D5	Diode 1N3062	28336-248
D6	Diode 1N3062	28336-248
D7	Diode 1N3062	28336-248
D8	Diode 1N3062	28336-248
D9	Diode 1N3062	28336-248
D10	Diode 1N3062	28336-248
D11	Diode 1N3062	28336-248
D12	Diode 1N3062	28336-248
D13	Diode 1N4148	28336-076
R1	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321
R2	Met film 1.8kΩ 2% $\frac{1}{4}$W	24773-279
R3	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R4	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R5	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R6	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R7	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R8	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R9	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R10	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R11	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R12	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R13	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
X1	Ferrite bead	41372-006
X2	Ferrite bead	41372-006

Unit A16 pre-amplifier, modulator, counter amplifier, wide band amplifier

When ordering, prefix circuit reference with A16

Circuit reference	Description	M.I. code
C1	Cer 0.001μF +80-20% 500V	26383-242
C2	Cer 0.01μF +80-20% 100V	26383-055
C3	Cer 0.001μF +80-20% 500V	26383-242
C4	Cer 0.001μF +80-20% 500V	26383-242

For symbols and abbreviations see introduction to this chapter

Circuit reference		Description	M.I. code
C5		Cer 10pF 20% 500V	26343-121
C6		Cer 47pF 20% 500V	26343-113
C7		Cer 0.01μF +80-20% 100V	26383-055
C8		Cer 0.01μF +80-20% 100V	26383-055
C9		Cer 0.001μF +80-20% 500V	26383-242
C10		Cer 0.01μF +80-20% 100V	26383-055
C11		Cer 0.01μF +80-20% 100V	26383-055
C12		Cer 1pF ±0.5pF 500V	26343-101
C13		Cer 0.01μF +80-20% 100V	26383-055
C14		Cer 0.001μF +80-20% 500V	26383-242
C15		Cer 0.001μF +80-20% 500V	26383-242
C16		Cer 0.001μF +80-20% 500V	26383-242
C17		Cer 0.001μF +80-20% 500V	26383-242
C18		Cer 0.001μF +80-20% 500V	26383-242
C19		Cer 0.001μF +80-20% 500V	26383-242
C20		Cer 0.1μF +50-25% 30V	26383-031
C21	†	Cer 3.3pF ±0.5pF 63V	26343-459
C22		Cer 0.001μF +80-20% 500V	26383-242
C23		Cer 0.01μF +80-20% 100V	26383-055
C24		Cer 0.01μF +80-20% 100V	26383-055
C25		Cer 0.001μF +80-20% 500V	26383-242
C26		Cer 0.01μF +80-20% 100V	26383-055
C27		Cer 0.001μF +80-20% 500V	26383-242
C28		Cer 220pF 20% 500V	26383-134
C29		Cer 0.001μF +80-20% 500V	26383-242
C30		Cer 0.01μF +80-20% 100V	26383-055
C31		Cer 0.001μF +80-20% 500V	26383-242
C32		Cer 0.01μF +80-20% 100V	26383-055
C33		Cer 0.001μF +80-20% 500V	26383-242
C34		Cer 0.001μF +80-20% 500V	26383-242
C35		Cer 0.001μF +80-20% 500V	26383-242
C36		Cer 68pF 20% 500V	26343-163
C37		Cer 82pF 20% 500V	26383-134
C38		Cer 0.001μF +80-20% 500V	26383-242
C39		Cer 18pF 20% 500V	26343-129
C40		Cer 18pF 20% 500V	26343-129
C41		Cer 0.001μF +80-20% 500V	26383-242

Circuit reference		Description	M.I. code
C42		Cer 0.01μF +80-20% 100V	26383-055
C43		Cer 10pF 20% 500V	26343-121
C44		Cer 18pF 20% 500V	26343-468
C45	†	Cer 2.2pF 10% 63V	26582-418
C46 to C49	†	Cer 0.001μF +80-20% 500V	26383-242
C50		Cer 2.7pF ±0.5pF 500V	26343-109
C51	†	Cer 3.3pF ±0.5% 500V	26343-111
D1, D2		See p.42, detector diodes	
D3-D6, D11-D14		Matched set of eight diodes	44529-007
D7, D8		PIN diode	28383-999
D9, D10		See p.42, detector diodes	
L1		Inductor 100μH 10%	23642-561
L2		Inductor 100μH 10%	23642-561
L4		Inductor 33μH 10%	23642-558
R1		Met film 82Ω 2% $\frac{1}{4}$W	24773-247
R2		Met film 43Ω 1% $\frac{1}{4}$W	24762-533
R3		Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R4		Met film 6.8Ω 2% $\frac{1}{4}$W	24773-221
R5		Met film 270Ω 2% $\frac{1}{4}$W	24773-259
R6		Met film 200Ω 2% $\frac{1}{4}$W	24773-256
R7		Met film 250Ω 2% $\frac{1}{4}$W	24773-259
R8		Met film 200Ω 2% $\frac{1}{4}$W	24773-256
R9	†	Met film 39Ω 2% $\frac{1}{4}$W	24773-239
R10		Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R11		Met film 22Ω 2% $\frac{1}{4}$W	24773-233
R12		Met film 270Ω 2% $\frac{1}{4}$W	24773-259
R13		Met film 120Ω 2% $\frac{1}{4}$W	24773-251
R14		Met film 270Ω 2% $\frac{1}{4}$W	24773-259
R15		Met film 47Ω 2% $\frac{1}{4}$W	24773-241
R16		Met film 150Ω 2% $\frac{1}{4}$W	24773-253
R17		Met film 15kΩ 2% $\frac{1}{4}$W	24773-301
R18		Met film 15kΩ 2% $\frac{1}{4}$W	24773-301

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R19	Met film 15Ω 2% $\frac{1}{4}$W	24773-229
R20	Met film 82Ω 2% $\frac{1}{4}$W	24773-247
R21	Met film 200Ω 2% $\frac{1}{4}$W	24773-256
R22 †	Met film 68kΩ 2% $\frac{1}{4}$W	24773-317
R23	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R24	Met film 470Ω 2% $\frac{1}{4}$W	24773-265
R25	Met film 5.6kΩ 2% $\frac{1}{4}$W	24773-291
R26	Met film 6.8kΩ 2% $\frac{1}{4}$W	24773-293
R27	Met film 200Ω 2% $\frac{1}{4}$W	24773-256
R28	Met film 390Ω 2% $\frac{1}{4}$W	24773-263
R29	Met film 15Ω 2% $\frac{1}{4}$W	24773-229
R30 †	Met film 56kΩ 2% $\frac{1}{4}$W	24773-315
R31	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R32	Met film 82Ω 2% $\frac{1}{4}$W	24773-247
R33	Met film 200Ω 2% $\frac{1}{4}$W	24773-256
R34 †	Met film 12kΩ 2% $\frac{1}{4}$W	24773-299
R35	Met film 430Ω 2% $\frac{1}{4}$W	24773-264
R36	Met film 82Ω 1% $\frac{1}{4}$W	24762-569
R37	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R38	Met film 560Ω 2% $\frac{1}{4}$W	24773-267
R40	Met film 22Ω 2% $\frac{1}{4}$W	24773-233
R41 †	Met film 68Ω 2% $\frac{1}{4}$W	24773-245
R42	Met film 390Ω 2% $\frac{1}{4}$W	24773-263
T1	Transformer	43590-009
T2	Transformer	43590-009
TR1	Transistor BFR90	28452-167
TR2	Transistor BFR90	28452-167
TR3	Transistor BFY90	28452-157
TR4	Transistor BFY90	28452-157
TR5	Transistor BFR90	28452-167
TR6	Transistor BFY90	28452-157
TR7	Transistor BFY90	28452-157
TR8	Transistor BFY90	28452-157
X3	Ceramic bead	23213-146

Unit A17 ALC and AM driver

When ordering, prefix circuit reference with A17

Circuit reference	Description	M.I. code
C1	Cer 0.01μF +80-20% 100V	26383-055
C2	Cer 0.1μF +50-20% 30V	26383-031
C3	Elec 22μF +100-20% 25V	26415-805
C4	Elec 47μF +100-20% 40V	26415-810
C5	Elec 47μF +100-20% 40V	26415-810
C6	Elec 10μF +100-20% 63V	26415-802
C7	Plas 2.2μF 10% 63V	26582-418
C8	Cer 100pF 20% 500V	26343-167
C9	Cer 100pF 20% 100V	26343-167
C10	Cer 0.01μF +80-20% 100V	26383-055
C11	Elec 22μF 20% 15V	26486-583
C12	Cer 100pF 20% 500V	26343-167
C13	Cer 100pF 20% 500V	26343-167
C14 †	Plas 5500pF 2% 125V	26516-666
D1, D2	See p.42, detector diodes	
D3	Diode 1N4148	28336-676
D4, D5	See p.42, detector diodes	
IC1	μA741 (operational amplifier)	28461-304
R1	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R2	Met film 1kΩ 2% $\frac{1}{4}$W	24773-273
R3	Met film 4.7kΩ 2% $\frac{1}{4}$W	24773-289
R4	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R5	Carb var. 220Ω 10% $\frac{1}{2}$W	25711-546
R6 †	Met film 560Ω 2% $\frac{1}{4}$W	24773-267
R7 †	Met film 390Ω 2% $\frac{1}{4}$W	24773-261
R9	Met film 22kΩ 2% $\frac{1}{4}$W	24773-305
R10	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R12	Met film 5.6kΩ 2% ¼W	24773-291
R13	Met film 15kΩ 2% ¼W	24773-301
R14	Met film 1kΩ 2% ¼W	24773-273
R15	Met film 430Ω 2% ¼W	24773-264
R16	Met film 2.7kΩ 2% ¼W	24773-283
R17	Met film 1kΩ 2% ¼W	24773-273
R18	Met film 430Ω 2% ¼W	24773-264
R19	Met film 15kΩ 2% ¼W	24773-301
R20	Met film 2.2kΩ 2% ¼W	24773-281
R21	Met film 4.3kΩ 2% ¼W	24773-288
R22	Met film 3.3kΩ 2% ¼W	24773-285
R23	Met film 36kΩ 2% ¼W	24773-310
R24	Met film 36kΩ 2% ¼W	24773-310
R25	Met film 8.2kΩ 2% ¼W	24773-295
R26	Met film 8.2kΩ 2% ¼W	24773-295
R27	Met film 120kΩ 2% ¼W	24773-323
R28	Met film 12kΩ 2% ¼W	24773-299
R29	Met film 27kΩ 2% ¼W	24773-307
R30	Met film 47kΩ 2% ¼W	24773-313
R31	Met film 1.5kΩ 2% ¼W	24773-277
R32	Met film 6.2kΩ 2% ¼W	24773-292
R33	Met film 680Ω 2% ¼W	24773-269
R34	Met film 2kΩ 2% ¼W	24773-280
R35	Met film 5.6kΩ 2% ¼W	24773-291
R36	Met film 15kΩ 2% ¼W	24773-301
R37	Met film 27kΩ 2% ¼W	24773-307
R38	Met film 27kΩ 2% ¼W	24773-307
R39	Carb 470kΩ 5% 1/8W	24311-937
R40	Carb 470kΩ 5% 1/8W	24311-937
TR1	Transistor BCY71	28435-235
TR2	Transistor BCY71	28435-235
TR3	Transistor BC109	28452-777
TR4	Transistor BC107	28455-437
TR5	Transistor BC107	28455-437
TR6	Transistor BC107	28455-437
TR7	Transistor BC107	28455-437
TR8	Transistor BCY70	28434-857
TR9	Transistor BCY70	28434-857
TR10	Transistor BCY70	28434-857

Unit (A18) Monitors

When ordering, prefix circuit reference with A18

Circuit reference	Description	M.I. code
C1	Plas 0.47μF 10% 63V	26582-410
C2	Elec 22μF +100-20% 25V	26415-805
C3	Plas 0.47μF 10% 63V	26582-410
D1	Diode 1N4148	28336-676
D2	Diode 1N4148	28336-676
D3	Diode 1N4148	28336-676
D4	Diode 1N4148	28336-676
D5	Diode 1N4148	28336-676
D6	Diode 1N4148	28336-676
R1	Met film 1.1kΩ 2% ¼W	24773-274
R2	† Met film 3.3kΩ 2% ¼W	24773-285
R3	Carb var 2.2kΩ 20% 0.21W	25711-547
R4	Met film 4.7kΩ 2% ¼W	24773-289
R5	Carb var 10kΩ 10% ½W	25711-543
R6	Met film 27kΩ 2% ¼W	24773-307
R7	Met film 220kΩ 2% ¼W	24773-329
R8	Met film 2.2kΩ 2% ¼W	24773-281
R9	Thermistor 1.5kΩ (CZ3)	25683-644
R10	Met film 680Ω 2% ¼W	24773-269
R11	Met film 1.5kΩ 2% ¼W	24773-277
R12	Met film 10kΩ 2% ¼W	24773-297
R13	Met film 3.3kΩ 2% ¼W	24773-285
R14	Met film 4.7kΩ 2% ¼W	24773-289
R15	Met film 4.3kΩ 2% ¼W	24773-288
R16	Met film 3.9kΩ 2% ¼W	24773-287
R17	Carb var 47kΩ 10% 5W	25711-549
R18	Met film 5.1kΩ 2% ¼W	24773-290

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
R19	Met film 2.2kΩ 2% ¼W	24773-281
R20	Met film 8.2kΩ 2% ¼W	24773-295
R21	Met film 10kΩ 2% ¼W	24773-297
R22	Carb var 220Ω 10% ½W	25711-546
R23	Carb var 1kΩ 10% ½W	25711-544
R24	Met film 15kΩ 2% ¼W	24773-301
R25	Met film 10kΩ 2% ¼W	24773-297
R26	Met film 2.2kΩ 2% ¼W	24773-281
TR1	Transistor BC108	28452-787
TR2	Transistor BC109	28452-777

Unit (A19) modulation oscillator and FM drive

When ordering, prefix circuit reference with A19

Circuit reference	Description	M.I. code
C1	Plas 0.018μF 2% 125V	26516-786
C2	Plas 0.018μF 2% 125V	26516-786
C3	Elec 22μF +100-20% 25V	26415-805
C4	Cer 0.047μF +50-20% 30V	26383-018
C5	Elec 22μF +100-20% 25V	26415-805
C6	Plas 0.47μF 10% 63V	26582-410
C7	Elec 100μF 20% 10V	26486-606
C8	Elec 100μF 20% 10V	26486-606
C9	Elec 22μF 20% 15V	26486-583
R1	Met film 18kΩ 2% ¼W	24773-303
R2	Met film 18kΩ 2% ¼W	24773-303
R3	Met film 2.2kΩ 2% ¼W	24773-281
R4	Met film 680Ω 2% ¼W	24773-269
R5	Met film 22kΩ 2% ¼W	24773-305
R6	Met film 9.1kΩ 2% ¼W	24773-296
R7	Thermistor 20kΩ (RA54) 20%	25683-387
R8	Met film 1kΩ 2% ¼W	24773-273
R9	Met film 100kΩ 2% ¼W	24773-321
R10	Met film 560Ω 2% ¼W	24773-267
R11	Met film 6.8kΩ 2% ¼W	24773-293
R12	Car var. 2.5kΩ 20% 0.21W	25541-322
R15	Met film 82kΩ 2% ¼W	24773-319
R16	Met film 220kΩ 2% ¼W	24773-329
R17	Met film 10kΩ 2% ¼W	24773-297
R18	Met film 100Ω 2% ¼W	24773-249
R19	Met film 100Ω 2% ¼W	24773-249
R20	Met film 100Ω 2% ¼W	24773-249
R21	Met film 100Ω 2% ¼W	24773-249
R22 †	Met film 240Ω 2% ¼W	24773-258
R23 †	Met film 22kΩ 2% ¼W	24773-305
R25	Met film 220Ω 2% ¼W	24773-257
R26	Met film 9.1kΩ 2% ¼W	24773-296
R27	Met film 10kΩ 2% ¼W	24773-297
R28	Met film 2.2kΩ 2% ¼W	24773-281
R29 †	Met film 220Ω 2% ¼W	24773-257
R30 †	Met film 270Ω 2% ¼W	24773-259
TR1	Transistor BC108	28452-787
TR2	Transistor BCY71	28435-235
TR3	Transistor BCY71	28435-235
TR4	Transistor BC108	28452-787
TR5	Transistor BC108	28452-787

Unit (A20) power supply

When ordering, prefix circuit reference with A20

Circuit reference	Description	M.I. code
C2	Elec 100μF +100-20% 25V	26423-244
C3	Cer 0.0047μF +80-20% 100V	26383-321
C4	Tant 4.7μF 20% 35V	26486-219
C5	Elec 100μF +100-20% 25V	26423-243
C6	Cer 0.01μF +100-20% 100V	26383-055
C7	Plas 1μF 10% 63V	26582-414
C8	Plas 2.2μF 10% 63V	26582-418
C9	Cer 0.1μF +50-20% 30V	26383-031
D1	Diode 1N4004	28357-028
D2	Diode 1N4004	28357-028
D3	Diode 1N4004	28357-028
D4	Diode 1N4004	28357-028

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
D5	Diode Zener BZY88C8V2	28371-679
D7	Diode 1N4004	28357-028
R1	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281
R2	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281
R3	Met film 12kΩ 2% $\frac{1}{4}$W	24773-299
R4	Preset 2.2kΩ 20% 0.21W	25711-547
R5	Met film 7.5kΩ 2% $\frac{1}{4}$W	24773-294
R6	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281
R7	Met film 1.5kΩ 2% $\frac{1}{4}$W	24773-277
R8	Met film 24kΩ 2% $\frac{1}{4}$W	24773-306
R9 †	Met film 2.7kΩ 2% $\frac{1}{4}$W	24773-283
R10 †	Met film 6.8kΩ 2% $\frac{1}{4}$W	24773-293
R11	Met film 2.2kΩ 2% $\frac{1}{4}$W	24773-281
R12	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R13	Met film 13kΩ 2% $\frac{1}{4}$W	24773-300
R14 †	Met film 3kΩ 2% $\frac{1}{4}$W	24773-284
R15	Met film 100Ω 2% $\frac{1}{4}$W	24773-249
R16	Met film 3.3kΩ 2% $\frac{1}{4}$W	24773-321
R18	WW 1.5kΩ 5% 1.5W	25123-084
TR2	Transistor BFY51	28455-827
TR3	Transistor BC108	28452-787
TR4	Transistor MM4001	28438-436
TR5	Transistor BCY71	28435-235
TR6 †	Transistor BF244B (complete with matched resistors R9 and R10)	46883-258
TR7	Transistor BC239C	28452-771
TR8	Transistor BC239C	28452-771

Unit A21 fine tuning

When ordering, prefix circuit reference with A21

C1	Plas 0.47μF 10% 63V	26582-410
C2	Elec 22μF 20% 15V	26486-583
C3	Plas 0.1μF 10% 100V	26582-211
R1 †	Met film 6.8kΩ 2% $\frac{1}{4}$W	24773-293
R2	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R4	Met film 2kΩ 2% $\frac{1}{4}$W	24773-280
R5	Met film 2kΩ 2% $\frac{1}{4}$W	24773-280
R6	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R7	Met film 220kΩ 2% $\frac{1}{4}$W	24773-329
R8	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R9	Met film 150kΩ 2% $\frac{1}{4}$W	24773-325
R10	Carb 1MΩ 5% $\frac{1}{4}$W	24311-945
R11	Carb 1MΩ 5% $\frac{1}{4}$W	24311-945
TR1	Transistor BFW11	28459-012

Unit A22 coarse RF output (attenuator)

When ordering, prefix circuit reference with A22

CAM	10dB	31359-022
CAM	20/1dB	31359-021
CAM	20/2dB	31359-019
CAM	30/1dB	31359-018
CAM	30/2dB	31359-020
R1	Met film 790Ω 1% $\frac{1}{4}$W	24762-646
R2	Met film 790Ω 1% $\frac{1}{4}$W	24762-646
R3	Met film 247Ω 1% $\frac{1}{4}$W	24762-631
R4	Met film 247Ω 1% $\frac{1}{4}$W	24762-631
R5	Met film 71.2Ω 1% $\frac{1}{4}$W	24762-572
R6	Met film 53.3Ω 1% $\frac{1}{4}$W	24762-557
R7	Met film 53.3Ω 1% $\frac{1}{4}$W	24762-557
R8	Met film 53.3Ω 1% $\frac{1}{4}$W	24762-557
R9	Met film 53.3Ω 1% $\frac{1}{4}$W	24762-557
R10	Met film 61.1Ω 1% $\frac{1}{4}$W	24762-571
R11	Met film 61.1Ω 1% $\frac{1}{4}$W	24762-571
R12	Met film 61.1Ω 1% $\frac{1}{4}$W	24762-571
R13	Met film 61.1Ω 1% $\frac{1}{4}$W	24762-571
R14	Met film 96.3Ω 1% $\frac{1}{4}$W	24762-582
R15	Met film 96.3Ω 1% $\frac{1}{4}$W	24762-582
SA	Microswitch UHF	23483-131
SB	Microswitch UHF	23483-131
SC	Microswitch UHF	23483-131

For symbols and abbreviations see introduction to this chapter

Circuit reference	Description	M.I. code
SD	Microswitch UHF	23483-131
SE	Microswitch UHF	23483-131
SF	Microswitch UHF	23483-131
SG	Microswitch UHF	23483-131
SH	Microswitch UHF	23483-131
SJ	Microswitch UHF	23483-131
SK	Microswitch UHF	23483-131

Unit A23 FM predistortion—temperature compensation

When ordering, prefix circuit reference with A23

Circuit reference	Description	M.I. code
C1	Elec 4.7μF 20% 35V	26486-219
C2	Elec 4.7μF 20% 35V	26486-219
D1	Diode 1N4148	28336-676
D2	Diode 1N4148	28336-676
R1	Carb 680kΩ 5% 1/8W	24311-941
R2	Met film 10kΩ 2% $\frac{1}{4}$W	24773-297
R3	Met film 100kΩ 2% $\frac{1}{4}$W	24773-321
R4	Met film 56kΩ 2% $\frac{1}{4}$W	24773-315
R5	Met ox 820kΩ 2% $\frac{1}{2}$W	24573-143
R6	Met ox 330kΩ 2% $\frac{1}{2}$W	24573-133
R7	Resistor assembly 270Ω	44359-003
R8	Met film 220Ω 2% $\frac{1}{4}$W	24773-257
R9	Met film 560Ω 2% $\frac{1}{4}$W	24773-321
R10	Thermistor 1.5kΩ (CZ3)	25683-644
R11	Met film 820Ω 2% $\frac{1}{4}$W	24773-271

Miscellaneous

Circuit reference	Description	M.I. code
	Cap and chain (TNC)	23444-898
	Control knob	
	Function	41145-407
	Carrier range	41145-407
	Fine tune	41141-708
	Tune	41149-014
	Extra fine tune	41149-016
	Set mod	41149-002
	Deviation	41149-002
	AM depth	41149-002
	Stepped r.f. output	41145-407
	Fine r.f. output	41149-002
	Cursor (pointer assembly)	41179-898
	Drive cord	16410-604
	Drive cord spring	31119-017
	Drive cord pin	33900-110
	Handle (strap)	37587-925
	Handle (attachment)	37588-110
	Handle (end caps)	22315-573
	Scale 10-14.3 MHz	31759-004
	14.3-20.5 MHz	31759-005
	20.5-29.9 MHz	31759-006
	29.4-42 MHz	31759-007
	42-60 MHz	31759-008
	60-86 MHz	31759-009
	86-124 MHz	31759-010
	124-177 MHz	31759-011
	177-254 MHz	31759-012
	254-363 MHz	31759-014
	363-520 MHz	31759-021
	Scale window	37490-020
	Spiral bevel gears (carrier range switch) pair	31318-406 31318-407

For symbols and abbreviations see introduction to this chapter

Index to Units

Unit number	M.I. code	Description	Parts list page	Circuit diagram Fig.
A0	-	Chassis and panel components	42	All
A1	44827-137	Oscillator range 1	44	7.1
A2	44827-138	Oscillator range 2	44	7.1
A3	44827-139	Oscillator range 3	44	7.1
A4	44827-140	Oscillator range 4	44	7.1
A5	44827-141	Oscillator range 5	45	7.1
A6	44827-142	Oscillator range 6	45	7.1
A7	44827-143	Oscillator range 7	45	7.1
A8	44827-144	Oscillator range 8	46	7.1
A9	44827-145	Oscillator range 9	46	7.1
A10	44827-146	Oscillator range 10	46	7.1
A11	44827-147	Oscillator range 11	46	7.1
A12	44827-148	Mother board	47	7.1
A16	44827-152	Pre-amplifier, modulator, counter amplifier, wide band amplifier	47	7.2
A17	44827-153	ALC and AM driver circuits	49	7.2
A18	44827-154	Monitors	50	7.2
A19	44827-155	Modulation oscillator and FM drive	51	7.3
A20	44827-105	Power supply	51	7.4
A21	44827-222	Fine tuning circuits	52	7.3
A22	44429-004	Coarse RF output (attenuator)	52	7.4
A23	44827-366	Predistortion circuits	53	7.3

Chapter 7

Circuit diagrams

Circuit notes

1. COMPONENT VALUES

Resistors: No suffix = ohms, k = kilohms, M = megohms.
Capacitors : No suffix = microfarads, p = picofarads.
Inductors : No suffix = henrys, m = millihenrys, μ = microhenrys.
† value selected during test, nominal value shown.

2. VOLTAGES

Shown in italics adjacent to the point to which the measurement refers. See Sect 5. 2 for conditions.

These symbols indicate the method used for voltage measurements at various points.

* Use 4.7kΩ resistor in series with meter. Position resistor at test point.

● Use 100 V meter range

■ see Table 5. 2.

3. SYMBOLS

Symbols are based on the provisions of B. S. 3939

arrow indicates clockwise rotation of knob.

RANGE etc. , external front or rear panel marking.

2 tag on printed board.

preset control.

A12 unit identification number.

These symbols are used to identify branches of the power supply circuitry but have no particular physical reality on the printed boards.

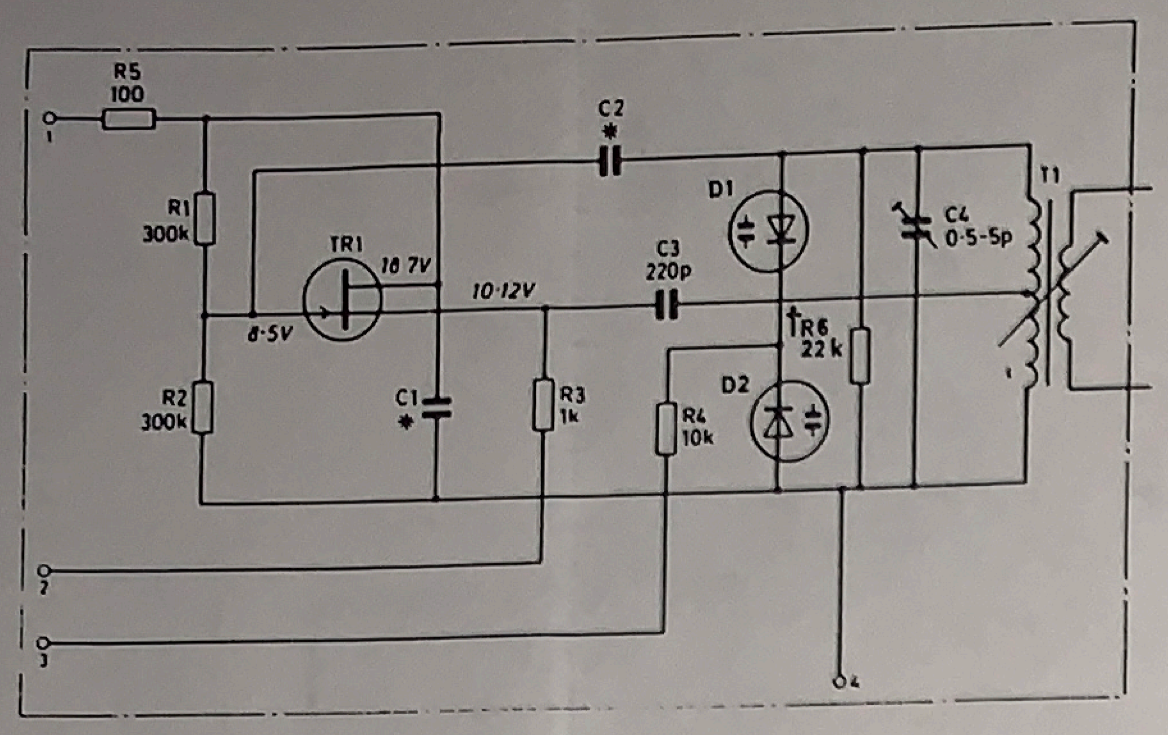
A point marked with this symbol is connected to and receives power from A point marked with this symbol.

4. CIRCUIT REFERENCES

These are, in general, given in abbreviated form. See also introduction to Chap. 6.

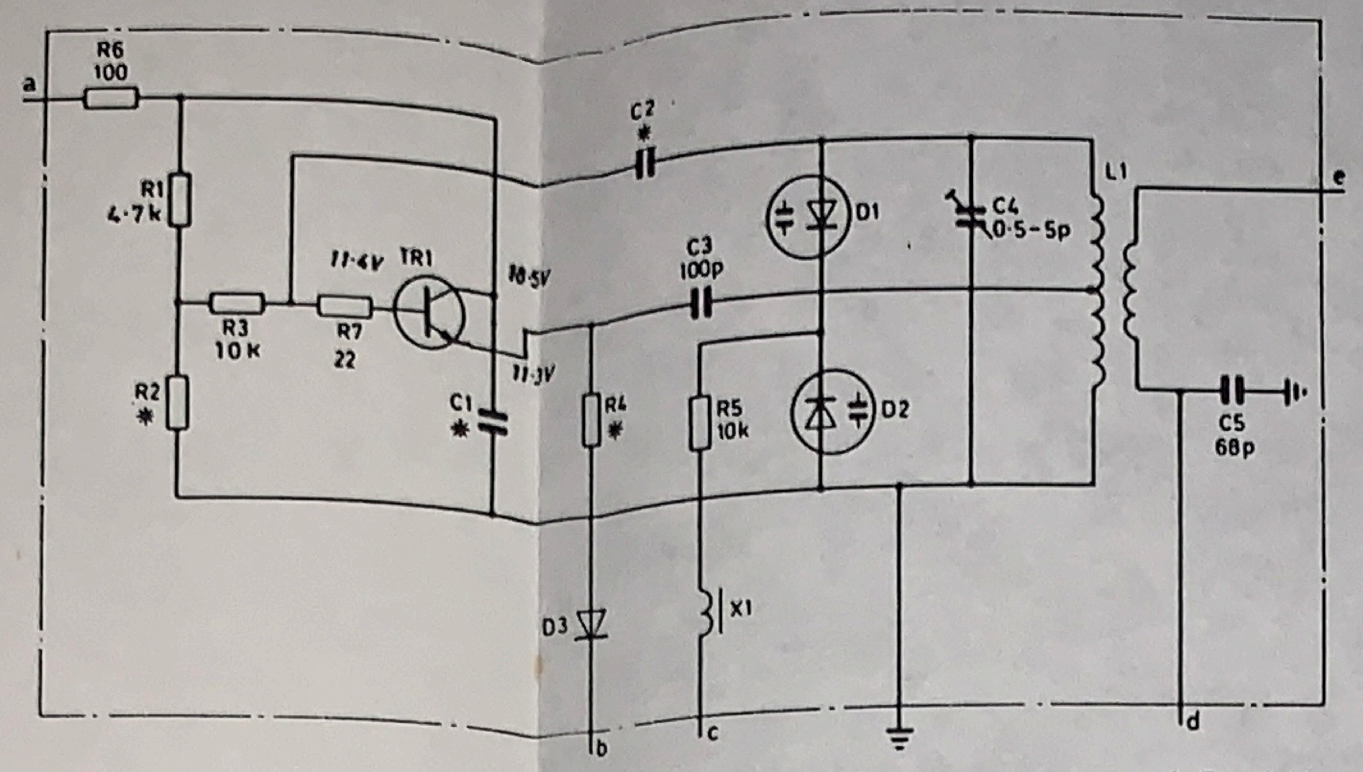
5. SWITCHES

Rotary switches are drawn schematically.
Letters or figures indicate control knob settings.
1F = 1st section (front panel), front.
1B = 1st section, back
2F = 2nd section, front.
etc.



Circuit diagram of Boards A1 to A9

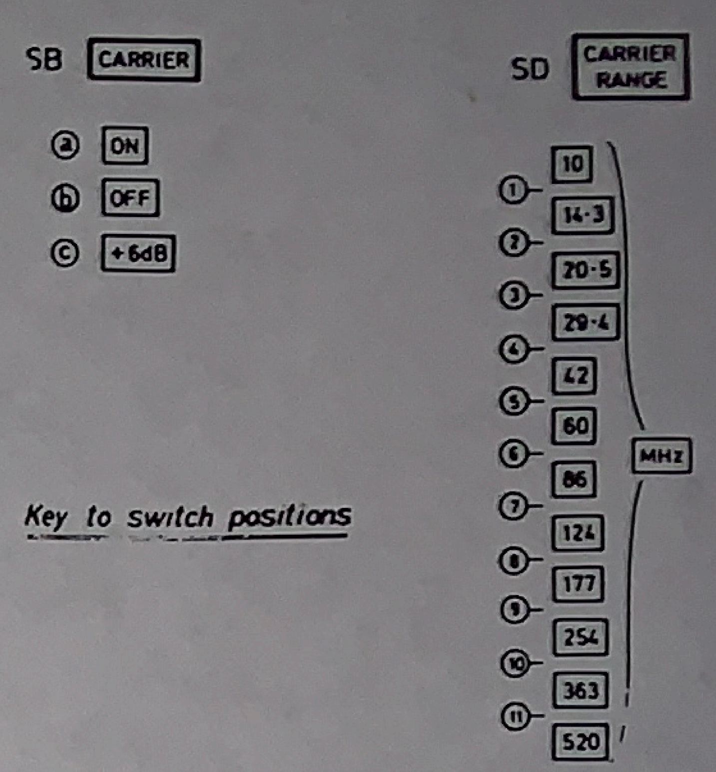
* See table



Circuit diagram of Boards A10 and A11

* See table

BOARD	COMPONENT			
	C1	C2	R2	R4
A1	·01	10p †		
A2	·01	12p †		
A3	·001	15p †		
A4	·001	10 p †		
A5	·001	10 p †		
A6	·001	5·6p †		
A7	680p	18p †		
A8	470p	12p †		
A9	330p	10p †		
A10	220p	2·2 p	10k	2·2k
A11	100p	3·3 p †	3·3k	1k



Key to switch positions

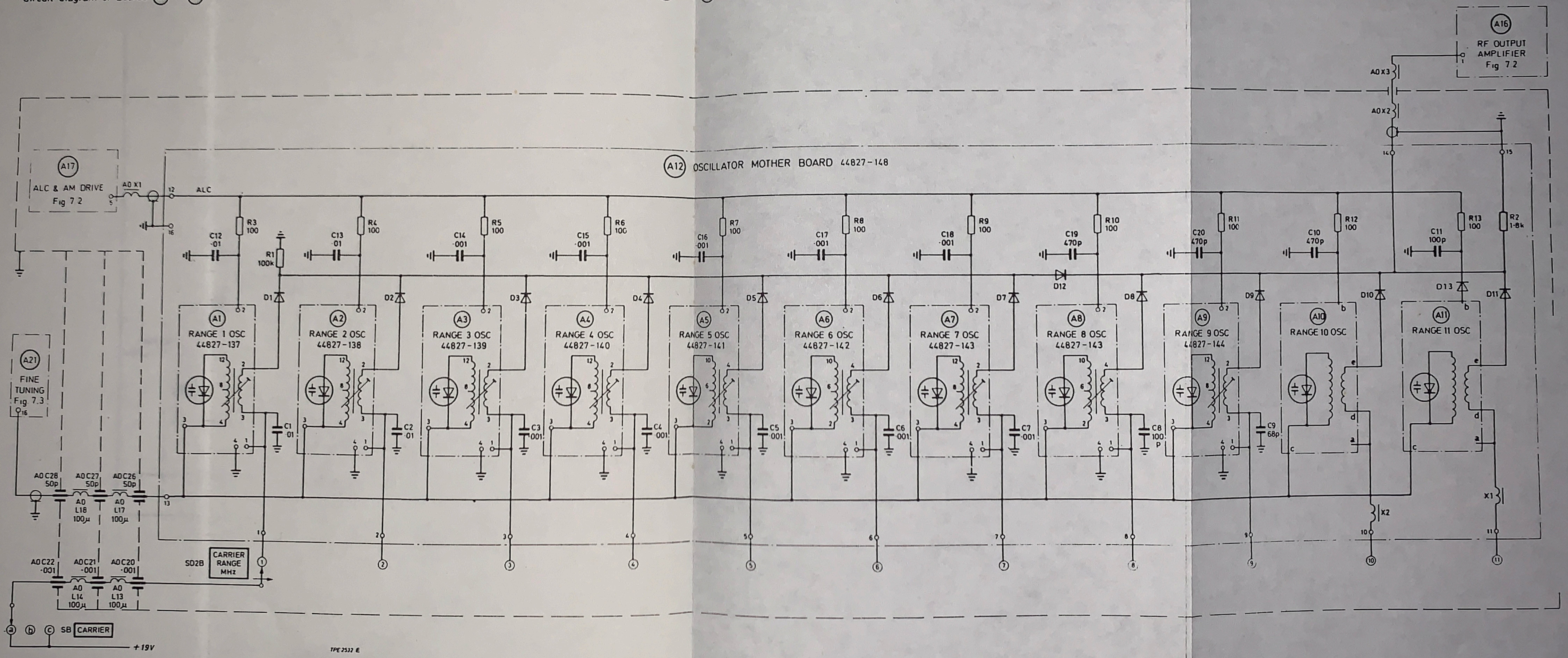


Fig. 7.1 Oscillator mother board

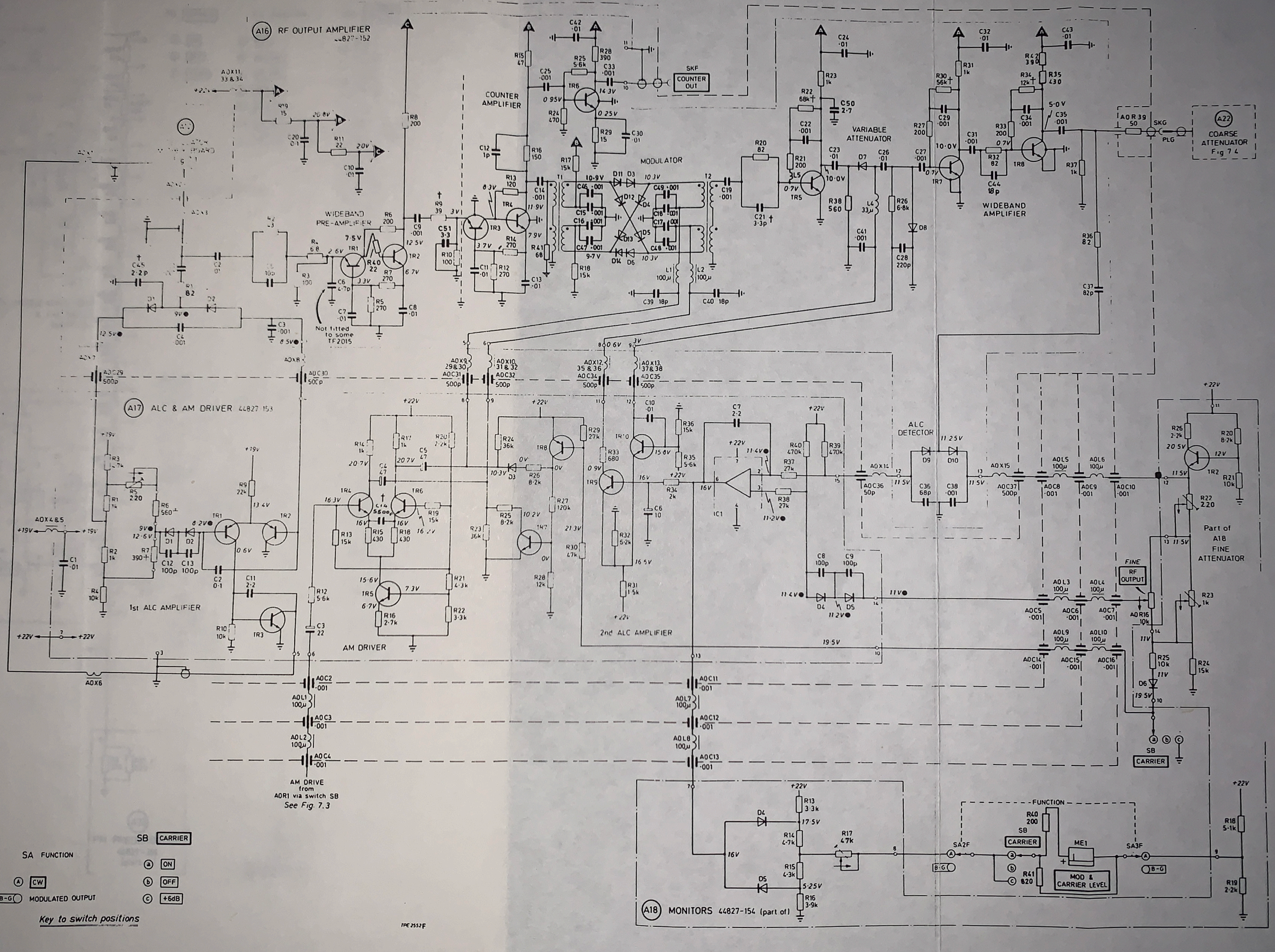


Fig. 7.2 RF Amplifier, ALC and AM

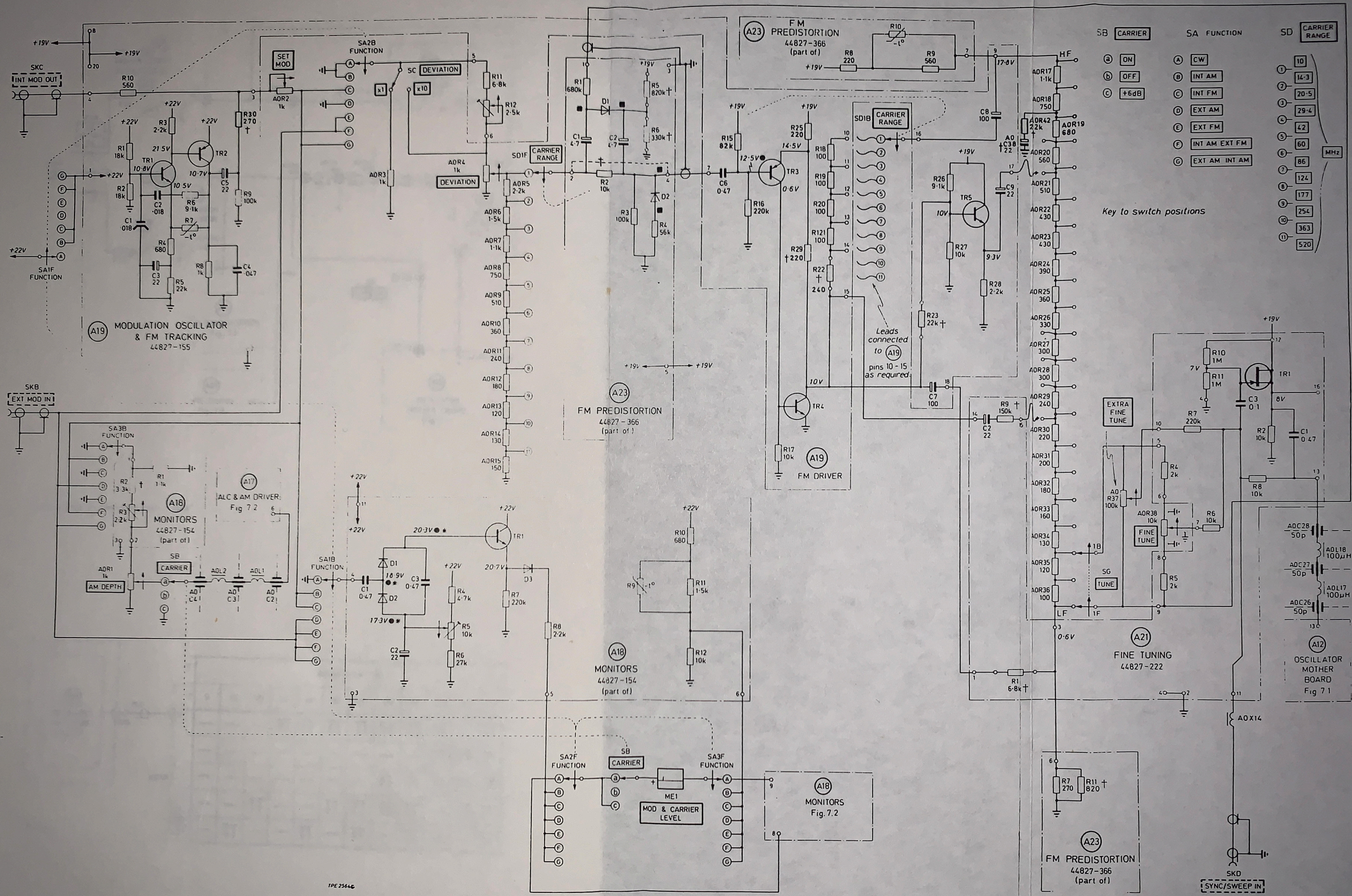
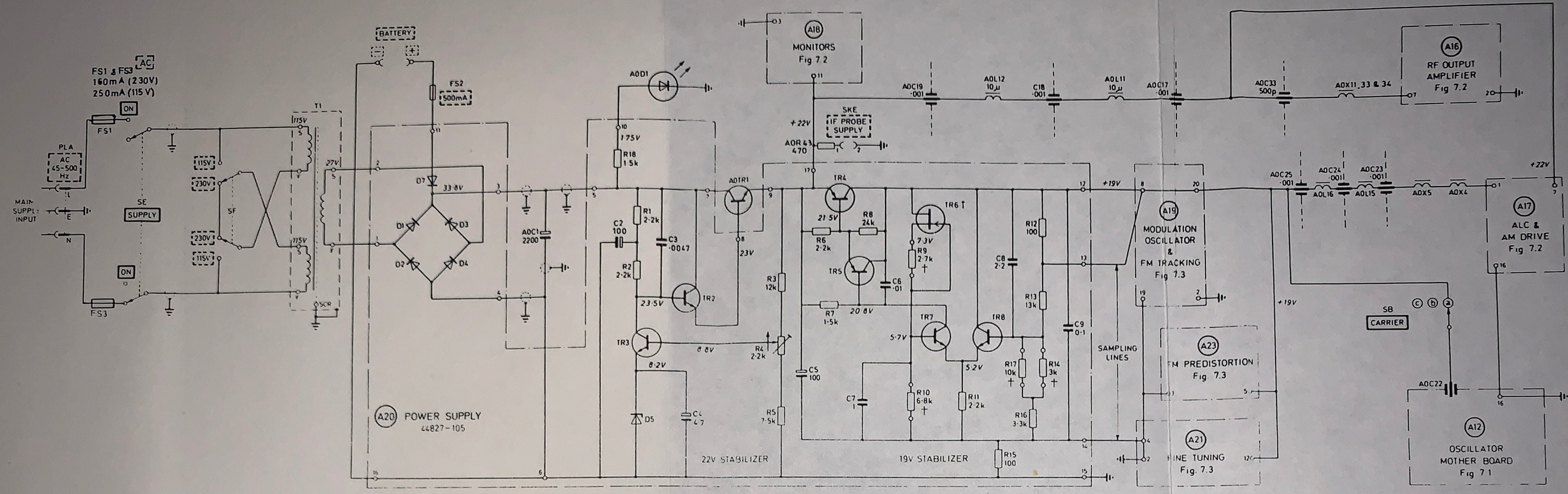
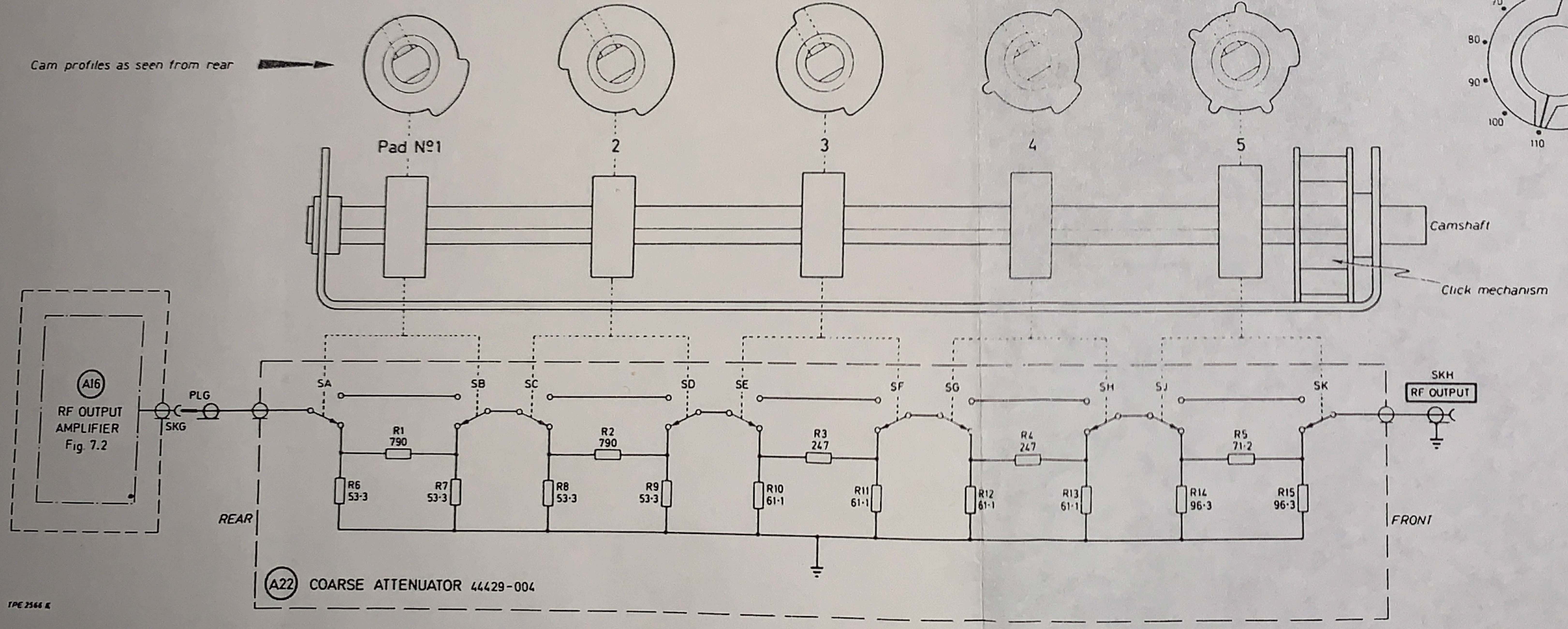
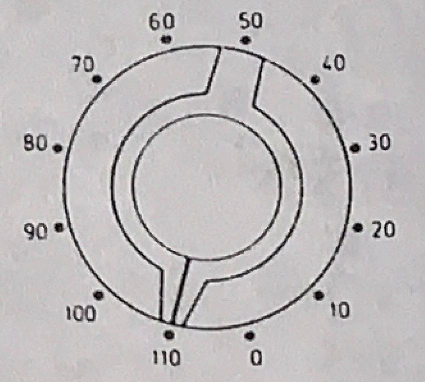


Fig. 7.3 Tuning, modulation and predistortion







Pad sections in circuit		Attenuation dB											
dB	Pad Nº	0	10	20	30	40	50	60	70	80	90	100	110
30	1	—	—	—	Π	Π	Π	Π	Π	Π	Π	Π	Π
30	2	—	—	—	—	—	—	—	—	—	Π	Π	Π
20	3	—	—	—	—	—	—	—	Π	Π	Π	Π	Π
20	4	—	—	Π	—	—	Π	Π	Π	Π	—	Π	Π
10	5	—	Π	—	—	Π	—	Π	—	Π	Π	—	Π

Fig. 7.4 Power supply and coarse attenuator

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